Physiological studies on some cotton varieties infected with *Fusarium oxysporum* f.sp. *vasinfectum*.

By

Abdou Mahdy Mohamed Mahdy

B.Sc. Agriculture,1976.

Zagazig University

Thesis

Submitted in Partial Satisfaction of the Requirements for the degree

of

Master of Science

In

Plant Physiology

Plant Pathology and Genetics Department, Faculty of Agricultural Science, Moshtohor.

Zagazig University

(Benha Sector)

1981

APPROVAL SHEET

Zagazig University (Benha Sector)
Faculty of Agricultural Science, Moshtohor
Plant Pathology and Genetics Department

Name of Student: Abdou Mahdy Mohamed Mahdy

Degree : M.Sc. in Agriculture (Plant physiology)

Title of Thesis: Physiological studies on some cotton varieties infected with *Fusarium oxysporum* f.sp. *vasinfectum*.

Approved by:

Prof Dr. [signature]

Prof Dr. [signature]

Prof Dr. [signature]

(Committee in Charge)

Date: 27/ 6/1981.

CONTENTS

ACKNOWLEDGMENT

The auther wishes to express his sincere appreciation and gratitude to Prof. Dr. Abdel-Hady Abdel-Aziz Khadr Prof. of Plant Physiology and Dr. Nawal Abdel-Moneim Eisa, Associate Prof. of Plant Pathology, Plant Pathology and Genetics Department, Faculty of Agricultural Science, Moshtohor, for their supervision, help and constructive criticism throughout this work.

The auther also would like to express his deep thanks and gratitude to Prof. Dr. Ibrahim Fathy Gamal El-Din, Prof. of Plant Pathology and Vice Dean of the Faculty of Agricultural Science, Moshtohor, and Dr. Kamal Galal Mohamed Ahmed, Associate Prof. of Plant Pathology, Plant Pathology and Genetics Department, Faculty of Agricultural Science, Moshtohor, Zagazig University, Benha Sector, for their great help in this work.

I extend my thanks also to Prof. Dr. Mohamed Fawzy Abdel-Hamied, Head of the Department; Plant Pathology and Gentices,and Dr. Raafat S.Abdel-Aal Associate Prof. of Soils, Soils and Agricultural Chemistry Department, Faculty of Agricultural Science, Moshtohor and Dr. Abdel-Rasheed Shehata, Associate Prof. of Soil Chemistry, National Research Centre, Dokki, Cairo, for their great help in facilitating the chemical analysis of the leaf Samples of this work.

Thanks also to all the members of Plant Pathology and Genetics Department for their help and encouragement.

INTRODUCTION

Cotton (*Gossypium barbadense* L.) is the most essentail field crop in Egypt. It is the most important exporting and cash crop of the country. In addition a good part of the crop is manufactured localy. The ministry of Agriculture estimated the area of cotton grown in 1979 as 1195529 feddans which yielded 9671897 metric kintar.

Egyptian cotton is usually subjected to various insects, fungi and physiological diseases.

The cotton *Fusarium* wilt disease is endemic to cotton growing areas in Egypt particularly in the far northern regions. The disease had been, and it is still, associated with the rise and fall of the highly praised long staple cultivars, begining with sakel and ending with Karnak and Giza 74. The loss resulted from the deterioration and abolishment of some varieties which could be expressed as poor stand and markedly reduced yield of the surviving plants which might be otherwise overcome the early seedling wilt. Such loss increases gradually year after year until it reachs a point that the economical cultivation of susceptible cultivars becomes valueless.

Since long time ago plant workers have been traying to solve these problems by extensive research.

This study is mainly concerned with testing the physiological role of each nutrient in maintaining a vigorous growth of cotton plants and resisting cotton *Fusarium* wilt caused by *Fusarium oxysporum* f. sp. *vasinfectum*. Hoping by this to obtain good yield of cotton grown in infested soil.

REVIEW OF LITERATURE

Causal:-

Fusarium wilt disease of cotton has been extensively investigated in Egypt by Briton — Jones in (1922) and the causal is now known as *Fusarium oxysporum* Schlecht.f. sp.*vasinfectum* (Atk.) Snyder and Hansen.

The Nutrient elements affecting pathogenicity

I- Effect of macronutrient elements (Nitrogen, Phosphorus, Potassium and Calcium):-

Rost (1922) stated that, the use of a mixture of fertilizers containing nitrogen, phosphorus and potash was useful in controlling cotton wilt.

Neal (1927) working on cotton wilt (*Fusarium oxysporum* f. sp. *vasinfectum*) recorded that, potassium reduced the percentage of diseased plants grown in the green house.

In field trails done by Miles (1936) in Mississippi over a period of couple of years;he showed that adding high potash fertilizer particularly to the potassium-deficient soils, consistently reduced the amount of cotton wilt.

Smith (1940) stated that higher levels of nitrogen increased susceptibility of cotton to *Fusarium* wilt.

Confirmatory results in Arkansas were secured by Young and Tharp (1941). On the other hand they pointed out that addition of nitrogen and/or phosphorus to the same soil (potassium deficient) increased wilt. They interpreted these results as either due to the direct influence of N and P elements upon the disease or to shortage of K caused by N and P addition. Furthermore, Stoddard (1942) reported, that, muskmelon wilt (*Fusarium oxysporum* f.sp. *melonis*) was increased in sand culture when relatively law potassium and relatively high nitrogen level were used in the nutrient solution.

Tiodale and Dick (1942) showed that potash in combination with nitrogen and phosphate fertilizers reduced wilt. Foster and Walker (1947) proved that high nitrogen level reduced infection of *Fusarium* wilt of tomato caused by *Fusarium oxysporum* f.sp. *lycopersici* and that high phosphorus is believed to increase the resistance of tomato to *Fusarium*.

McNew (1953) indicated that the addition of barnyard manure to wilt infested cotton fields reduced the amount of wilt. He also stated that cotton wilt was most severe in the potash deficient soils.

Smith (1953) recommended use of balanced fertilizers to maintain a vigorous growth of cotton plants as an important cultural practice to prevent losses from cotton wilt. He added that potash trends to reduce wilt losses. Nitrogen and phosphorus tend to increase wilt within certain limits. The proper balance of nitrogen, phosphorus and potash gives the maximum yields and best control of wilt when no one of the three elements is deficient.

Ashour *et al.* (1964) reported that higher levels of nitrogen increased susceptibility of cotton to *Fusarium* wilt.

Mohamed and Darrag (1964) found that nitrogen increased *Fusarium* wilt of cotton in the absence of potassium but had a little effect when potassium sulphate was also applied.

Naim and Shabaa(1965) found that the susceptibility and vigour of Karnak and Bahtim 190 cotton, varied with,

Fusarium strains tested, and N fertilizers, whereas Ashmouni was conistently resistant. This last variety (Ashmouni) was not affected by K deficiency as was found by Sharoubeem *et al.* (1966) on his work on *Fusarium* wilt while in the susceptible Karnak, low or high K reduced wilt incidence and moderate level enhanced it.

El-Nur and Fattah (1970) showed that nitrogenous fertilizers tended to increase the incidence of *Fusarium* wilt in susceptible *Gossypium barbadence* cultivars, but the resistance of cultivar Ashmouni was not affected.

Fahim *et al.* (1971) found that the addition of potassium sulphate or calcium supper phosphate or both to the soil reduced the amount of *Fusarium* wilt, while the addition of nitrogen had no effect compared with control. The combination of the three fertilizers nitrogen, phosphorus and potassium was consistently the most effective treatment that reduced the amount of infection. They mentioned that wilt incidence was much reduced when potassium or phosphorus or any combination of the three fertilizers were added to the soil long enough before the seedlings were inoculated.

Paletskaya *et al.* (1973) found that on soils very poor in organic matter ammonium sulphate, urea, potassium nitrate and sodium nitrate had no effect on the severity of cotton wilt caused by *Fusarium oxysporum* f. sp. *vasinfectum* but infection was reduced by fertilizing with compost from lucern roots and ammonium nitrate or ammonium sulphate, synthesis of phytotoxin by pathogen depended only slightly on the type of N fertilizer.

Fisher (1935) and Edington and Walker (1958) found that, severity of *Fusarium* wilt of tomato caused by *Fusarium oxysporum* f. *lycopersici* was generally increased by dificient while decreased by excess calcium nutrition.

The fact that calcium is required for growth regulator induced resistance to *Fusarium* wilt suggested a role for this ion in the wilt syndrome (corden and Edington 1960).

Corden (1965) found that severity of tomato wilt caused by *Fusarium oxysporum* f. *lycopersici* was increased by calcium deficiency accurred especially after the infection, while it decreased when the deficiency accurred before infection.

II- Effect of micronutrient elements:-

Young (1947) stated that, the use of boron-containing soil amendments did not reduce the incidence of infection.

Sulochana (1952a) found from pot experiment involving treatment of (wilt-sick) soils wilt trace elements at levels ranging from 50 to 400 ppm, that viability of *Fusarium vasinfectum* on infected cotton stubble buried in infected soil was decreased by AL, Li, B, Mn and Zn. He also added that Zn was the most effective element in this respect. Furthermore, Sulochana (1952b) indicated that cotton benefited from Zn and Mn treatment while B did not affect germination and Zn appeared to be efficient in reducing wilt incidence, and Mn in aggravating it.

Sadasivan and subramanian (1954) and Sadasivan (1958) found that the addition of heavy metals such as boron, zinc, iron and manganese to the soil resulted in a reduction in wilt incidence.

Stepantsev (1957) reported a decrease in *Fusorium* wilt of cotton after soil application of boron or manganese.

Kuzentsov (1964) stated that orewaste and molybdenum ash reduced the incidence of wilt by 50% and increased yield by more than 20%.

Karaev (1965) reported that, the addition of mineral fertilizers some what reduced Fusarium oxysporum f.sp. vasinfectum infection in cotton and increased yield.

Fahim et al. (1971) reported that presooking of cotton seeds of the variety karnak for different periods in a solution containing any of the microelements boron, zinc, copper, manganese or molybdenum decreased wilt incidence. This incidence decreased with the increase of microelement concentration or presooking peroids. Zinc and boron proved to be the most efficient in reducing disease severity.

Cotton plant growth:-

Naim and Shabaa (1965) found that with N fertilizers the vigour of cotton plants was reduced most by the common strain of F. oxysporum f.sp. vasinfectum. Infection by Fusarium Solani sometimes increased root and shoot length, but dry weight was low. The susceptibility and vigour of Karnak and

Bahtim 190 cotton varied with the Fusarium strains tested and N fertilizers, whereas Ashmouni was consistently resistant.

Naim et al.(1966) found that in sand cultures deficient in N produced a higher incidence of Fusarium oxysporum f.sp. vasinfectum on the susceptible variety Karnak and lowered host vitality of this in the resistant Ashmouni. N levels up to 100 ppm reduced severity and raised host vigour, while moderate levels (100-300 ppm) increased both the wilt and host vigour and levels of(500-1000 ppm) reduced them. The presence of F. oxysporum f.sp. vasinfectum promoted growth vigour in seedlings of both varieties at concentrations up to 250 ppm.

Sharoubeem et al.(1966a) mentioned that the appearance of K deficiency symptoms in sand cultures of cotton plants were retarded by the presence of F.oxysporum f.sp. vasinfectum or F. moniliforme. K deficiency did not affect the resistance of variety Ashmouni to Fusarium wilt but in the susceptible Karnak low or high K reduced wilt incidence while moderate levels enhanced it. Maximum leaf area was obtained

with 100 ppm K, and maximum root dry weight with 200-250 ppm. Low or high K increased the water content of tops. Although, the introduction of either pathogen increased both leaf area and dry weight of the plant tops compared with the uninfected controls.

Sugars:

Subbtima (1961) analysed leaves of normal and wilted plants of beans for total carbohydrates, (soluble sugars and starch) and found that wilting increased soluble sugars while markedly decreased total carbohydrates

R'ohringer et al.(1961), however, did not detect any differance in sugar content of resistant and susceptible tomato varieties to Fusarium oxysporum f. sp. lycopersici.

Mathre (1968) found that, infected Acala -4-42 cotton leaves with the defoliating strain of Verticillium alboatrum decreased starch content.

Youssef and Youssef (1971) studying the effect of infection with Fusarium oxysporum f.sp.vasinfectum on sugar content of two varieties of Egyptian cotton, found that maltose,

sucrose, galactose and glucose were the sugars detected in "Giza 68" plants raised in uninoculated or inoculated soil No qualitative or quantitative changes appeared to occur.

Harfoush (1975) reported that carbohydrate contents of been plants infected with F.oxysporum were less than that of healthy plants in seminal and Giza-3 varieties.

Phenolic compounds:-

Many experimental data has shown that a correlation may exist between the degree of resistance to wilt and phenol level in healthy plants, also many experimental data in pathophysiology support the view that the phenolic level is higher in diseased plants than in healthy ones.

Mahandevan (1966) found that the resistance mechanism of cotton against Fusarium oxysporum vasinfectum was attributed to phenolic compounds and their oxidation products.

Kati Reddy and Mahadevan (1967) found that catechol and phloretin, both constituents of cotton plants, effectively inhibited production of cellulase by Fusarium

oxysporum f.sp. vasinfectum when added to culture medium, whilst catechin and anthroquinane were moderately effective.

Bell (1969) found that gossypol, normally present in cotton, is produced more obundently in cotton following inoculation with vertillium and its role as a phytoalaxin has been suggested.

Anthoni Raj and Mahadevan (1970) found that pre-treatment of cotton plants with catechin conferred more protection against wilt symptoms than catechol, the resistance was against Fusarium oxysporum vasinfectum and pectinolytic enzymes. Catechin was more effective against the enzyme activity than the fungus. Catechal decreased the phenolic content of cotton plants while catechin slightly increased it. They also found that oxidized phenols reduced the wilt symptoms of plants; oxidized catechin conferred more protection against the enzyme which induce wilting than catechal. The phenol pool of plants decreased in response to treatment with oxidized phenols. Both phenols were phytotoxic.

Amino acids:-

Lakshminarayanan (1955) reported that cystine, occuring in large quantities in a tested resistant tetraploid cotton variety, appeared to be a limiting factor to wilt and presumably to fusaric acid output *in vivo*. They also found that nonprotein source of nitrogen in the host was more conductive to fusaric acid output and that the diploid susceptible varieties of cotton had less protein and more of the monprotein nitrogen.

R'ohringer *et al*. (1961) did not detect any differences in amino acid content of resistant and susceptible tomato varieties to *Fusarium oxysporum* f.sp. *lycopersici*.

Shaw (1963) stated that the mechanism of resistance or susceptibility seams to be based on the regulation of protein synthesis.

Leaf pigments:-

Mathre (1968) found that the decrease in the rate of photosynthesis was not directly related to the loss of chlorophyll due to infection with *verticillium albo-atrum*.

Krishnamani and Lakshmanan(1976) studied the resistant and susceptible cotton cultivars infected with *Fusarium vasinfectum* and found that infected leaves resulted in consistent reduction in total chlorophyll and chlorophyll b while they were not able to detect any direct correlation between loss of chlorophyll and low rate of photosynthesis. Chlorphylase activity was enhanced in the infected leaves.

Abou-Zaid (1977) reported that infection with *Fusarium oxysporum* f.sp. *vasinfectum* did not make any marked change in the cotents of chlorophyll (a) and (b) or that of total chlorophyll in the resisttant cultivars "Giza 69" in all stages of plant growth although slight increase was noticed in 60 days old seedlings.

Carotenoids gave the same trend except that a slight decrease was noticed after 60 days from planting, whereas the susceptible cultivar"Giza 74 " showed reduction in chlorophyll contents after 90 days old which might be due to the infection by the fungus. Carotenoids, increased in infected plants at the last stage of growth.

Foliar contents of nutrients:

Sharoubeem *et al*.(1966 b) reported that an increase in P in the sand culture medium up to 100 ppm increased the Ca content of the cotton vartetles Ashmouni and Karnak. But further increase in P reduced it. The Mg, P, and K contents in the plant tops were increased by an increase in P, while the effect on Mg and P being enhanced by the presence of *Fusarium oxysporum* f.sp. *vasinfectum*. At P levels of 200-500 ppm. *Fusarium* spp.increased Ca and decreased that of K in the plant tops.

Haag *et al*.(1971) found that plants of resistant and susceptible cotton varieties were wilted when grown in Brazil in a nutrient solution containing P and inoculated with *Fusarium oxysporum* f.sp. *vasinfectum*. Then the plants were exposed for 48 h to a solution containing radioactive P^{32}. P absorption was reduced by 45% in infected plants of the susceptible variety while infected plants of the resistant variety absorbed less P than healthy ones.

Nerozi and Belousov (1972) reported that plant response to N deficiency was expressed in decreases in P and K contents in the leaves.

Zhukova (1972) found that in sand culture trials with cotton deficiency or exclusion of K from the nutrient solution increased accumulation of disaccharides and starch in the leaves and decreased their accumulation in the stem indicating that K deficiency decreased the translocation of photosynthates from the leaves. K deficiency increased exudation of cell sap, contents of N and P especially in organic forms in the cell sap, and plant contents of free amino acids, amines; amides and Ca.

Fakhrudinova (1975) found in trials with cotton in Tadzhikistan that application of high P rates decreased the plant Zn contents. Applied K normalized the Zn and P uptake by plants.

MATERIALS AND METHODS

I- Nutrient studies:-

The effect of nutrients on cotton seedlings either infested with *Fusarium oxysporum* f.sp. *vasinfectum* or not was studied using sand culture technique.

Two varieties of cotton were used i.e. Giza 69 (Resistant) and Giza 74 (Susceptible).

Sand culture experiments were carried out under green-house conditions at the Faculty of Agricultural science, Moshtohor, Zagazing University ARE in March 1979 and 1980 seasons.

Preparation of sand and containers:-

White fine sand of about 0.8-1.00 mm in diameter was used. After sieving, sand was purified by soaking in 5% HCL for 3 days, followed by washing, for 3-days using a rapid stream of tap water. washing was continued until the pH of the sand became about 7.0. The sand was sterilized with 5% formalin solution (1 litre for one cubic foot of sand), covered with polyethylene for 2 days and then left under open air for two weaks for formalin evaporation.

Earthenware pots No.30 with a bottom drainage hole were used as containers. The hole was blocked with sponge to allow drainage of excess solution without escape of sand. The inner surface of the pots were coated with 3 Layers of butomin to render the walls impermeable to water and solution. Pots were sterilized by immersing in 5% formalin solution for 15 minutes and then left to dry out. The sand was placed on a 10 cm. Layer of gravel to obtain good drainage condition. The gravel was washed using the same method previously described for sand. Each pot was filled with 6 kg. of the sterilized clean dry sand.

The basic nutrient solution was prepared according to califorinia modified nutrient solution adapted by Arthur Wallace (1963).

The solution prepared as in Table (a) was used as basic treatment (control) and from which various levels of the nutrient elements were prepared. Calcium chloride, urea and phosphoric acid were used tc keep other nutrient concentrations constant in all treatments.

Table(a) Chemical composition of the nutrient solution used in treating the cotton plants (Giza 69 and Giza 74 varieties) infested with <u>Fusarium</u> <u>oxysporum</u>.f.s). <u>vasinfectum</u>.

	Salt	Conc.mole/L or ppm
1.	Calcium nitrate ($Ca(NO_3)_2 \cdot H_2O$)	0.0025 mole/L
2.	Urea $(NH_2)_2CO$	0.001
3.	Potassium dihydrogen phosphate(KH_2PO_4)	0.001
4.	Potassium sulphate (K_2SO_4)	0.001
5.	Magnesium sulphate ($MgSO_4 \cdot 7H_2O$)	0.002
6.	Manganise sulphate ($MnSO_4 \cdot H_2O$)	0.5 ppm
7.	Boric acid (H_3BO_4)	0.5
8.	Sodium molibdate ($NaMO_4 \cdot 2H_2O$)	0.1
9.	Copper sulphate ($Cu\ SO_4 \cdot 5H_2O$)	0.1
10.	Ferrous sulphate ($Fe\ SO_4 \cdot 7H_2O$)	5
11.	Zinc sulphate ($Zn\ SO_4 \cdot 4H_2O$)	3

Table (b) Different concentrations of the macronutrients as used in the different treatments.

Treatment	Concentration ppm	Salts
N_1	25	Calcium nitrate $(Ca(NO_3)_2 \cdot 4H_2O)$+Urea(NH_2CO)
N_2	50	Calcium nitrate $(Ca(NO_3)_2 \cdot 4H_2O)$+Urea(NH_2CO)
N_3	200	Calcium nitrate $(Ca(NO_3)_2 \cdot 4H_2O)$+Urea(NH_2CO)
N_4	300	Calcium nitrate $(Ca(NO_3)_2 \cdot 4H_2O)$+Urea(NH_2CO)
P_1	8	Potassium dihydrogen phosphate (KH_2PO_4)
P_2	16	Potassium dihydrogen phosphate $((KH_2PO_4)$
P_3	64	Potassium dihydrogen phosphate (KH_2PO_4) + Phosphoric acid (H_3PO_4)
P_4	[illegible]	Potassium di ydrogen phosphate + Phosphoric acid (H_3PO_4)
K_1	30	Potassium sulphate (K_2SO_4)
K_2	60	Potassium sulphate (K_2SO_4)
K_3	240	Potassium sulphate (K_2SO_4)
K_4	360	Potassium sulphate (K_2SO_4)
Ca_1	25	Calcium nitrate $(Ca(NO_3)_2 \cdot 4H_2O)$
Ca_2	50	Calcium nitrate $(Ca(NO_3)_2 \cdot 4H_2O)$
Ca_3	200	Calcium nitrate $(Ca(NO_3)_2 \cdot 4H_2O)$ + Calcium chloride $(Ca\,Cl_2)$
Ca_4	300	Calcium nitrate $(Ca(NO_3)_2 \cdot 4H_2O)$ + Calcium chloride $(Ca\,Cl_2)$

Table (c) Different concentrations of micronutrients as used in the different treatments.

Treatment	Concentration ppm	Salts
Zn_1	0.75	Zinc sulphate ($ZnSO_4.4H_2O$)
Zn_2	1.50	Zinc sulphate ($ZnSO_4.4H_2O$)
Zn_3	6.00	Zinc sulphate ($ZnSO_4.4H_2O$)
Zn_4	9.00	Zinc sulphate ($ZnSO_4.4H_2O$)
B_1	0.125	Boric acid (H_3BO_4)
B_2	0.250	Boric acid (H_3BO_4)
B_3	1.000	Boric acid (H_3BO_4)
B_4	1.500	Boric acid (H_3BO_4)
Cu_1	0.025	Copper sulphate ($CuSO_4.5H_2O$)
Cu_2	0.050	Copper sulphate ($CuSO_4.5H_2O$)
Cu_3	0.200	Copper sulphate ($CuSO_4.5H_2O$)
Cu_4	0.300	Copper sulphate ($CuSO_4.5H_2O$)
Mn_1	0.125	Manganise sulphate ($MnSO_4.H_2O$)
Mn_2	0.250	Manganise sulphate ($MnSO_4.H_2O$)
Mn_3	1.000	Manganise sulphate ($MnSO_4.H_2O$)
Mn_4	1.500	Manganise sulphate ($MnSO_4.H_2O$)

Two levels of each nutrient element were used in the first season i.e. half and double that of the control (Table a) concentration for each element in question. In the second season however, two additional levels of the element were used. The treatments then were one/forth, half, double and trible the original concentration of the element in the basic nutrient solution (Table b and c). These solutions were used for irrigation of pots sown with infested seeds of either Giza 69 (resistant variety) or Giza 74 (susceptible one). pots were artificially infested with a spore suspension of Fusarium oxysporum f.sp. vasinfectum and similar uninfested pots. were used as control.

These experiments were carried out during 1979 and 1980 season to study the effect of various nutrients on incidence of wilt disease and plant growth.

Preparation of spore suspension:-

An isolate of (Fusarium oxysporum f.sp. vasinfectum (Atk) Snyder and Hansen) was provided by Prof. Dr. El-Sharkawy, at Cotton Disease Research Division, Pl. Path. Inst. Agric. Res. Centre Ministry of Agric. The fungus was grown on Potato Dextrase Agar (PDA) for two weeks at 30°C to obtain the maximal sporulation. Ten ml. sterilized

distilled water were added to each Petri-dish and the spores were obtained by moving a small camel brush smoothly on the surface of the fungal growth to obtain the spore suspension, which was filterated through double layers of cheesecloth. The number of spores per one ml. was counted by using the Haemocytometer method.

Cotton seeds were surface sterilized by immersing in 0.01% mercuric chloride solution for three minutes then washed several times with sterilized distilled water and dried between two filter papers. Seeds then were soaked in the spore suspension(about 16 milion spore/ml.) for 12 hours and then removed and sown in the prepared pots as mentioned before. Ten ml. of spore suspension were thoroughly mixed with the sandy soil of each pot.

Infested seeds were sown at the rate of 15 and 7 seeds per pot were used for the first and the second seasons respectively, The nutrient solutions were added weekly to each pot starting from sowing until 5 weaks later, then the application of the nutrient solutions was twice a weak at the rate of one litre per pot.

Growth criteria and observations on seedling growth were determined and recorded as follows:-

1- <u>Percentages of seed germination, pre and post emergence damping-off and survivals</u>:

a- Percentages of seed germination were estimated 21 days after sowing as follows:-

$$\frac{\text{No. of germinated seeds}}{\text{Total number of seeds}} \times 100$$

b- Percentages of post-emergance damping-off were estimated 45 days after sowing as follows:

$$\frac{\text{No. of dead seedlings}}{\text{Total number of germinated seeds}} \times 100$$

c- Percentages of healthy survival plants were estimated 45 days after sowing as follows:

$$\frac{\text{No. of healthy survivals}}{\text{Total number of germinated seeds}} \times 100$$

2. <u>Morphological determinations</u>:

The following morphological measurments were recorded on samples taken after 90 days from sowing:-

a- Full plant length, i.e. the distance from root tip to stem tip in cms.

b- Stem length:- (the above ground foliage part) in cms.

c- Root length:- as obtained by substracting stem length from the whole plant length in cms.

d- Fresh and dry weights:- The fresh weight in mg per plant of samples taken 90 days after sowing was obtained then dried in an electric oven at 70°C for 43 hrs and then weighed and recorded.

3- Disease assessment:

Percentage of disease incidence was recorded five times starting 15 days from sowing periodically every 3 days and calculated as disease index and only the final one was recorded in the results using a scale containing 6 grades suggested by Perry (1962) to facilitate the differences between the various grades of susceptibility:-

Grade 0 = Apparently healthy plants.

Grade 1 = Plants with net chlorosis of cotyledonary leaves.

Grade 2 = Plants with yellowing and browning of cotyledonary leaves.

Grade 3 = Plants with yellowing and browning and chlorosis of the first ture leaf.

Grade 4 = Plants with dropping of cotyledonous leaves and yellowing in the first foliage leaves with slight brown colour.

Grade 5 = Plants with complete death of all leaves whether dropped or not and had the black colour.

The equation used for estimating disease incidence was as follows:

$$\text{Disease index} = \frac{(n_0 \times 0) + (n_1 \times 1) \ldots . (n_5 \times 5)}{n \times c} \times 100$$

Where (n) represents the number of plants of every grade and (c) number of grades

Chemical analysis:-

Leaf samples were taken after 45 days from sowing and divided into three groups. The first samples was washed with 0.1 N HCl, then distilled water and dried at 65°C till constant weight. The dry samples were ground in a porcelane china mortar and pestle and prepared for chemical analysis to determine macro and micronutrient elements as follows:-

Total nitrogen was determined by the digestion of 0.1 g plant material with sulphuric acid and perchloric acid and then measured by microkjyldahle according to Ranker (1927).

Phosphorus (P) was colorimetrically determined using ascorbic acid accordingto John(1968).

Potassium was measured by the flame photometer, model Garl Ziess and its concentration in plant tissues was calculated as K percentages on crude dry weight basis by using the method described by Brown and Lilliland (1946)

Calcium was determined by versinate, using ammonium perpiorate as an indicator, Jackson (1967).

For the determination of the micronutrients Iron (Fe) Manganese (Mn), Copper (Cu) and Zinc (Zn), the same wet digestion method was also used, using 0.5g plant material instead of 0.1g as recommended by Piper (1947). Such elements then were estimated by using a Pye Unican SP 90A atomic absorption spectrophotometer and calculated as parts per melion of Fe,Mn,Cu or Zn.

Determination of sugars, phenolic compounds, total amino acids and plant pigments:

The second part of leaf sample was extracted with ethanol as follows:

A representative sample , 1.5gm, was cut into small portions and immediately dropped into 95% boiling ethanol for ten minutes, to kill the tissues. The extraction was done in a Soxhlet apparatus using 75% ethanol as an extractant for 8-10 hrs until the percolate was colourless. The ethanolic extracts were filtered and evaporated till near dryness on a mild water bath at 60°C. The residue was redissolved in 5ml of 50% ispropanol and used for chemical anlysis as follows:

1- Determination of sugars:

Total and reducing sugars were determined colorimetrically with the picric acid method as described by Thomas and Dutcher (1924). The sugar content was calculated as glucose using a standard glucose curve. Two solutions were used for the determination of the total soluble and reducing sugars:-

(i) Picrate-picric solution was prepared as follows:
Thirty six grams of picric acid were added to 500ml. of a 1.0% solution of sodium hydroxide in one litre flask,

then 400 ml. of hot water were added and the mixture was shaken occasionally until the picric acid dissolved then solution was allowed to cool and diluted to one litre.

(ii) Sodium carbonate solution:- Twenty grams of sodium carbonate were dissolved in 100 ml of distilled water.

For the determination of total soluble sugars, 0.5ml of each samples was placed in a 70 CC test tube containing 5ml of distilled water plus 4ml. picrate-picric solution the mixture was boiled for 10 minutes, in a water bath. After cooling sodium carbonate, 1 ml. was added and the mixture was boiled again for 10 min, and completed to 50ml with distilled water after cooling. The optical density of the developed colour was measured by using specal spectrocalourimeter (Carl Zeiss, Jena) in the presence of a blank at wave length 540mU. The above technique was also applied for the determination of reducing sugars except that picratepicric and sodium carbonate were added together at the same time and boiled only for 10 minutes.

Non-reducing sugars were determined from the difference between the total soluble and reducing sugars. All these determinations were calaulated as milligrams glucose per 100 gm. fresh weight.

2- Determination of phenolic compounds:-

Phenolic compounds were determined using the colourimetric method of analysis described by Snell and Snell (1953) as follows:

Phosphotungstic-phosphomolybdic acid reagent: folin and ciocalteu phenol reagent according to Snell and Snell (1953), was prepared by transferring 100 gm sodium tungstate, 25gm; sodium molybdate and 700 ml. water into a 1500 ml. flask.

After that, 50 ml of 85% phosphoric acid and 100ml of concentrated hydrochloric acid were added, attached to a reflex condenser and boiled gentley for 10 hrs., then 150 gm. of lithium sulphate, 50 ml. of water, and few drops of liquid bromine were added. To remove excess bromine, the mixture was boiled without the attachment of the condenser, then cooled and diluted to one litre.

Free phenol was determined by adding 0.5ml. of this reagent and 1.5ml. of 20% solution of sodium carbonate to the sample diluted to 25ml. with warm water 30-35°C, let to stand for 20 min. and was read at wave length 520 mU against a reagent blank.

Free and conjugated phenols were determined as follows:-

Three drops of conc. HCl were added to the sample, heated rapidly to boiling using a free flame, with provision for condensation, and placed in a boiling water bath for 10 min.

After cooling the tubes, 0.5ml of the reagent and 1.5ml of a 20% $NaCO_3$ were added. The mixture was diluted to 25 ml and was determined after 20 min. at wave length 520 mμ against a reagent blank.

Conjugated phenols were determined by substracting the free phenols from total phenols.

3- Determination of total amino acids:

The total free amino acids were determined according to the method described by Rosen (1957). The method can be summarized as follows:

A volume of the ethanolic extract of leaf sample was added to half ml. of ninhydrine (3gm/100ml aceton) plus 0.5ml of acetate buffer (Ammonium hydroxide 10% + sodium acetate 10% adjusted at pH 8.3) in test tube.

Tubes containing the samples were placed in boiling water bath for 15 minutes and then were left to slow cooling at room temperature. The boiled extract was

diluted with distilled water to make up 20 ml. Colour developed in extracts was measured colorimetrically at wave length 650 mμ.

Total free amino acids were calculated as mg. leucine per 100gm fresh weight of the extracted tissues by the application of the standard curve which was made by using pure leucine.

4- Determination of plasto-pigments:

The plastid pigments were determined in the third part of the leaf sample by a modification of the spectrophotomatric procedure described for flue-cured tobacco by Bacot (1954) as follows: 2.5gm of sample in duplicate were extracted with 95 percent ethanol and acetone in mixing Blender. The extract was filtered, diluted with water and transferred to ether. The ether extract was dried after scrubbing with water and diluted to 100 ml with ether.

The pigment concentrations were determined by Spectrophotometer at wavelengths of 665,649,642.5, 485, 474 and 470 mμ at 200 ml as the final volume of the extract and reading the optical dessity using a cell having a path-length of 0.998 Cm. The following figures

are used for the calculation of the various pigment concentration.

Total chlorophyll	=	5566.5 D649
Chlorophyll a	=	1994.5 D665 - 173.4 D642.5
Chlorophyll b	=	3528.0 D642.5 - 607.0 D665
Total carotenoid	=	982.1 D474 - 0.255 (a)-0.2250(b)
Caratene	=	2518.2 D485 - 1198.5 D470 -0.0298(a)+ 0.3356 (b)
Xanthophyll	=	2026.1 D470 - 2288.6 D485+0.0036 (a)- 0.6518 (b).

EXPERIMENTAL RESULTS

I- The effect of seed infestation with *Fusarium oxysporum* f.sp.*vasinfectum* spores and different macronutrient elements on the percentages of germination, post-emergence damping-off and healthy survival plants of cotton varieties Giza 69 and Giza 74 were recorded in Table (1) in season 1979 and Table (2) in season 1980.

Data in Table(1) lead to the following results:-

1) Seed infestation with *F.oxysporum* f.sp. *vasinfectum* reduced their percentages of germination and healthy survivals. However, reduction was very serious in Giza 74 (the susceptible variety).

2) The increase in N-amounts to its double($N_3$200 ppm) reduced the percentages of germination and healthy survivals compared with normal nutrient solution (100 ppm). On the other hand, the increase in P-amounts(64 ppm) almost increased the percentages of both germination and healthy survivals in both cotton varieties especially the susceptible one. Compared with control II. Similar results were obtained as regards Ca-amounts with Giza 69 (the resistant variety). In this respect all the amount of P and K increased the percentages of healthy survivals especially at the low amounts and also the lower amounts of calcium in Giza 74 (susceptible variety) all compared with control II.

Table (1) Effect of seed infestation with *Fusarium oxysporum* f.sp. *vasinfectum* spores and different macronutrient elements on the percentages of germination, post-emergence damging-off and healthy survival plants of cotton varieties Giza-69 and Giza 74 in season 1979.

Treatments ppm.	Different cotton varieties					
	Giza 69 (Resistant)			Giza 74 (Susceptible)		
	Seed germination %	Post-emergence damping-off	Survival Plants %	Seed-germination %	Post-emergence damping-off %	Survival plants %
* Control I	96.67	0.00	96.67	93.33	0.00	93.33
** Control II	73.33	4.76	68.57	53.33	46.67	6.66
$N_2$50	73.33	0.00	73.33	42.00	22.22	19.78
$N_3$200	66.67	0.00	66.67	36.67	20.00	16.67
P_2 16	70.00	0.00	70.00	46.67	11.11	35.56
P_3 64	80.00	3.70	76.30	60.00	30.00	30.00
K_2 60	76.67	0.00	76.67	70.00	22.22	47.78
K_3 240	73.33	0.00	73.33	53.33	18.89	34.44
Ca_2 50	73.33	3.70	69.63	53.33	27.78	25.55
Ca_3 200	80.00	0.00	80.00	50.00	38.89	11.11
L.S.D. 0.05	N.S.	N.S.	N.S.	9.33	7.78	9.56

* Control I = Uninfested seeds grown in normal nutrient solution.
*** Control II= Infested seeds grown in normal nutrient solution.

Data recorded in Table (2) and Fig.(1) show clearly that:-

1) The increase in N-amounts to 3 times (N_4 300 ppm) than of the normal level (100 ppm) increased the percentage of post-emergence damping-off and decreased that of healthy survivals of both cotton varieties.

2) As regards P levels, the percentages of germination and healthy survivals increased at the second level (P_2 16 ppm) then decreased with the third level (P_3 64 ppm) and increased again at fourth level (P_4 100 ppm) in both cotton varieties.

3) In case of K levels, these percentages decreased with the increase in all amounts as regards the resistant variety Giza 69. The contrast was noticed in case of the susceptible variety Giza 74.

4) The increase in Ca levels, to the second (Ca_2 50 ppm) and third level (Ca_3 200 ppm) increased significantly the percentages of germination and healthy survivals then decreased at the fourth level (Ca_4 300 ppm) however, it was higher than the first level (Ca_1 25 ppm) in case of the resistant variety Giza 69 and lower than the first level (Ca_1 25 ppm) in case of Giza 74 the susceptible variety.

Table (2) : Effect of seed infestation with *Fusarium oxysporum* f.sp. *vasinfectum* spores and different macronutrient elements on the percentages of germination, post-emergence and healthy survival plants of cotton varieties Giza 69 and Giza 74 in Season 1980.

Treatment ppm.	Different cotton varieties					
	Giza 69 (Resistant)			Giza 74 (Susceptible)		
	Seed germination %	Post-emergence %	Survival plants %	Seed germination %	Post-emergence %	Survival plants %
* Control I	96.49	0.00	96.49	92.86	0.00	92.86
** Control II	57.14	5.00	52.14	53.57	13.33	40.24
N_1 25	67.86	0.00	67.86	53.57	0.00	53.37
N_2 50	64.29	0.00	64.29	53.57	0.00	53.57
N_3 200	67.86	5.00	62.88	46.00	0.00	46.43
N_4 300	67.86	17.50	50.36	42.86	6.25	36.61
P_1 8	71.43	6.25	65.18	50.00	8.33	41.67
P_2 16	75.00	0.00	75.00	50.00	6.25	43.75
P_3 64	64.29	0.00	64.29	42.86	13.83	29.03
P_4 100	78.57	6.25	72.32	42.86	0.00	42.86
K_1 30	75.00	4.17	70.83	39.29	16.67	22.62
K_2 60	71.43	9.17	62.26	39.29	0.00	39.29
K_3 240	67.86	0.00	67.86	50.00	0.00	50.00
K_4 360	53.57	0.00	53.57	64.29	0.00	64.29
Ca_1 25	57.14	4.17	52.97	53.57	14.58	38.99
Ca_2 50	78.57	0.00	78.57	53.57	0.00	53.57
Ca_3 200	78.57	0.00	78.57	60.71	0.00	60.71
Ca_4 300	60.71	0.00	60.71	39.29	20.83	18.46
L.S.D.0.05	11.54	N.S.	10.43	9.59	N.S.	8.05

* Control I = Uninfested seeds grown in normal nutrient solution.
** Control II = Infested seeds grown in normal nutrient solution.

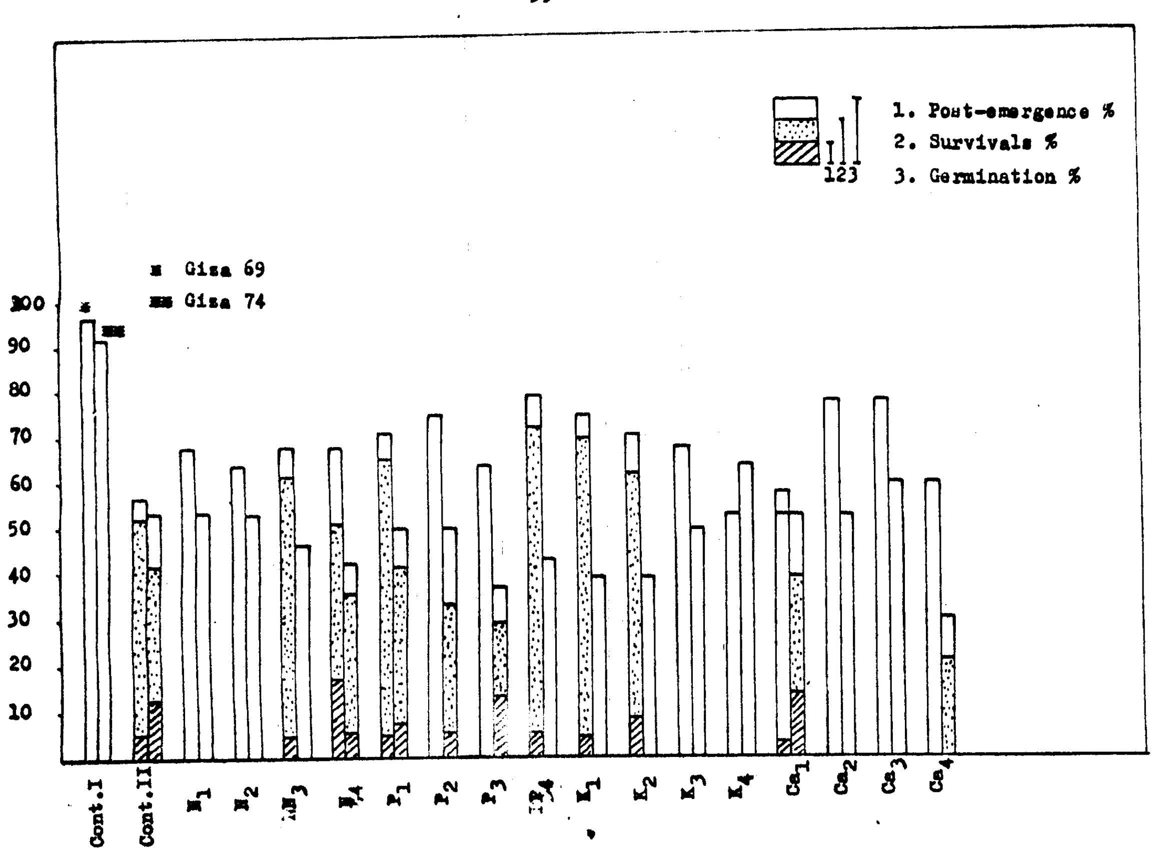


Fig.(1): Effect of seed infestation with *Fusarium oxysporum* f.sp. *vasinfectum* spores and different macronutrient elements on the percentages of germination, post-emergence and healthy survival plants of cotton varieties Giza 69 and Giza 74 in Season 1980.

Cont.I: = Uninfested seeds grown in normal nutrient solution.

Cont. II = Infested seeds grown in normal nutrient solution.

II- The effect of seed infestation with *Fusarium oxysporum* f. sp. *vasinfectum* spores and micronutrients on the percentages of germination. post-emergance damping -off and healthy survival plants was recorded in Table (3) for season 1979 and Table (4) for season 1980.

Data in Table (3) show the following results:

1) Seed infestation reduced the percentage of germination and healthy survivals and increased post-emergence of both varieties.

2) The increase in Zn-level (Zn_3 6ppm) increased both percentages of germination and healthy survivals in case of resistant Giza 69 variety. On contrast with the susceptible Giza 74 and decreased post-emergence.

3) With regard to B-levels similar trend as Zn was noticed in case of the resistant variety, whereas the percentages of germination were similar in the two levels in case of the susceptible variety. However, the percentages of healthy survivals increased with the increase in it's level to (1 ppm).

Table (3) Effect of seed infestation with *Fusarium oxysporum* f.sp. *vasinfectum* spores and different levels of micronutrient elements on the percentages of germination, Post-emergence and healthy survival plants of cttnn varieties Giza 69 and Giza 74 in Season 1979.

Treatment ppm.	Different cotton varieties					
	Giza 69 (Resistant)			Giza 74 (Susceptible)		
	Seed germination %	Post-emergence %	Survival plants %	Seed germination %	Post-emergence %	Survival Plants %
* Control I	96.67	0.00	96.67	93.33	0.00	93.33
** Control II	73.33	4.76	68.57	53.33	46.67	6.66
Zn_2 1.5	70.00	0.00	70.00	60.00	40.00	20.00
Zn_3 6.0	80.00	0.00	80.00	53.33	41.11	12.22
B_2 0.25	66.67	4.76	61.91	66.67	46.67	20.00
B_3 1.00	73.33	0.00	73.33	66.67	41.67	25.00
Cu_2 0.05	70.00	0.00	70.00	46.67	13.33	33.34
Cu_3 0.20	73.33	0.00	73.33	53.33	19.44	33.89
L.S.D. 0.05	13.41	N.S.	13.71	12.49	9.35	6.67

* Control I = Uninfested seeds grown in normal nutrient solution.

** Control II = Infested seeds grown in normal nutrient solution.

3) Similar trend of results as in B was noticed as regards Cu level in case of the resistant variety. With regard to the susceptible variety the percentage of germination increased with the increase of concentration but the percentages of healthy survivals were almost similar in both levels.

Data in Table (4) and Fig.(2) lead to the following results:

1) The increase in Zn level increased the percentages of both germination and healthy survivals then it decreased at the third level (Zn_3 6 ppm) and increased again as regards the resistant variety only. In case of the susceptible variety the decrease continued during the first (Zn_1 0.75 ppm) and second (Zn_2 1.5 ppm) levels then increased at the third level(Zn_3 6 ppm) then decreased again at Zn_4 (9 ppm) level however, the percentage of healthy survivals was almost similar in all levels in this regard.

2) As regards B levels the percentages of germination and healthy survivals increased with the increase in its level in the resistant variety. The opposite results were obtained as regards the susceptible one,except the survivals and germination that flactuated.

3) The increase in Cu-concentration than the first level, increased the percentages of germination and healthy survivals in the resistant variety, these percentages increased till the third level then decreased again in case of the susceptible variety.

4) In case of Mn levels the increase in these percentages reached the maximum at the second level (Mn_2 0.25 ppm) then decreased again in the resistant variety. These percentages were higher than the control at the first level then decreased at the second one, (Mn_2 0.25 ppm) followed by an increase in the third level (Mn_3 1 ppm) then decreased at the fourth level (Mn_4 1.5 ppm) in the susceptible variety.

Table (4): Effect of seed infestation with F.oxysporum f.sp. vasinfectum spores and different micronutrient elements on the percentages of germination, post-emergence and healthy survival plants of cotton varieties Giza 69 and Giza 74 in Season 1980.

Treatments ppm.	Different cotton varieties					
	Giza 69 (Resistant)			Giza 74 (Susceptible)		
	Seed germination %	Post-emergence %	Survival plants %	Seed germination %	Post-emergence %	Survival Plants %
* Control I	96.49	0.00	96.49	92.86	0.00	92.86
** Control II	57.14	5.00	52.14	53.57	13.33	40.24
Zn_1 0.75	82.14	0.00	82.14	42.86	0.00	42.86
Zn_2 1.50	82.14	0.00	82.14	50.00	0.00	50.00
Zn_3 6.00	67.88	9.17	58.71	64.29	12.5	51.79
Zn_4 9.00	75.00	5.00	70.00	50.00	0.00	50.00
B_1 0.125	67.86	6.25	61.61	57.14	0.00	57.14
B_2 0.250	64.41	0.00	64.41	53.57	11.25	42.32
B_3 1.00	73.33	0.00	73.33	46.43	0.00	46.43
B_4 1.50	75.00	0.00	75.00	50.00	6.25	50.00
Cu_1 0.25	60.71	6.25	54.46	42.00	13.33	28.67
Cu_2 0.05	73.33	4.17	69.16	46.43	0.00	46.43
Cu_3 0.20	70.00	4.17	65.83	53.57	13.33	40.24
Cu_4 0.30	71.43	4.17	67.26	46.43	0.00	46.43
Mn_1 0.125	67.86	8.33	59.53	57.14	8.25	48.89
Mn_2 0.25	82.14	6.25	75.89	53.57	6.25	47.32
Mn_3 1.00	71.43	0.00	71.43	60.71	5.00	55.71
Mn_4 1.50	60.71	37.50	23.21	53.57	14.58	38.99
L.S.D. 0.05	11.43	1.83	10.43	8.95	2.67	8.03

* Control I = Uninfested seeds grown in normal nutrient solution.

** Control II = Infested seeds grown in normal nutrient solution.

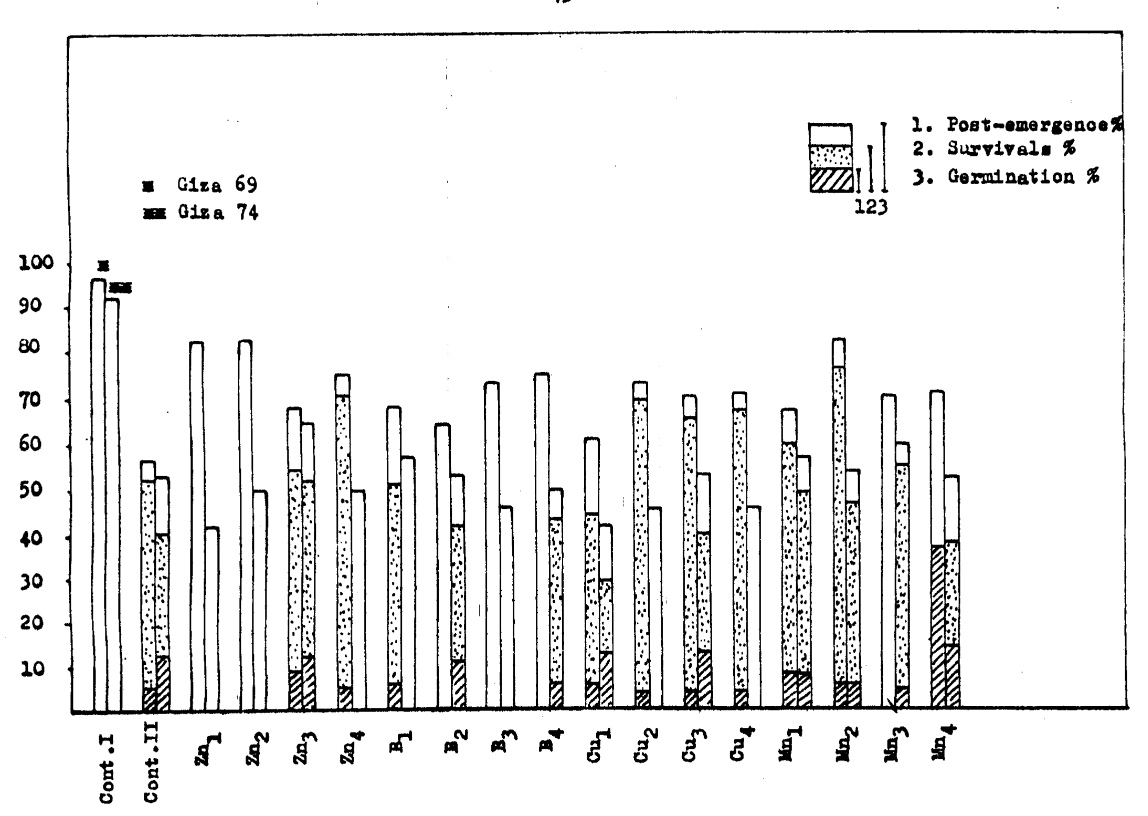


Fig.(2): Effect of seed infestation with F.oxysporum f.sp. vasinfectum spores and different micronutrient elements on the percentages of germination, post-emergence and healthy survival plants of cotton varieties Giza 69 and Giza 74 in Season 1980.

Cont.I = Uninfested seeds grown in normal nutrient solution.

Cont.II = Infested seeds grown in normal nutrient solution.

III- The effect of seed infestation with *F. oxysporum* f.sp. *vasinfectum* spores and different macronutrients on both disease index after 30 days from sowing and plant growth after 90 days from sowing were recorded in Table (5) for season 1979 and Table (6) for season 1980.

Data of Table (5) lead to the following results:-

1) As regards the resistant variety, the increase in N-element increased disease index. However, N_2 level (50 ppm) increased both the fresh and dry weights of root system and shoot system. N_3 level (200 ppm) increased the average length and to a little degree the fresh and dry weights of the shoot system, compared to control II.

   Similar trend of results was noticed as regards the susceptible variety especially at N_3-level (200 ppm) which showed high increases in all the recorded data compared to control II.

2) On the other hand, P-levels increased the disease index and reduced the other recorded data except fresh weight which increased compared with control II in case of the resistant variety. However, a great reduction in the disease index of the susceptible variety was noticed especially at P_2-level (16 ppm), this

Table (5): Effect of seed infestation with F.oxysporum f.sp. vasinfectum and macronutrient elements on disease index during 30 days after sowing and plant growth after 90 days from sowing of different cotton varieties in Season 1980.

Treatments ppm.	Different cotton varieties													
	Giza 69 (Resistant)							Giza 74 (Susceptible)						
	Disease index %	Root System			Shoot System			Disease index %	Root System			Shoot System		
		Ave. length cm.	Ave. fresh Wt.mg.	Ave. dry Wt.mg.	Ave. length cm.	Ave. fresh Wt.mg.	Ave. dry Wt.mg.		Ave. length cm.	Ave. fresh Wt.mg.	Ave. dry Wt.mg.	Ave. length cm.	Ave. fresh Wt.mg.	Ave. dry Wt.mg.
*Control I	0.00	16.49	602	241	15.41	1511	642	0.00	13.92	269	127	11.17	867	374
**Control II	2.76	17.00	499	189	15.46	1489	581	42.21	20.08	492	205	13.17	1222	457
N_2 50	3.208	16.45	518	201	15.45	1713	590	28.33	14.83	298	161	9.08	738	309
N_3 200	5.556	15.16	490	190	16.62	1546	549	32.73	19.92	525	233	18.25	1925	665
P_2 16	3.580	13.70	344	124	15.12	1615	467	11.11	13.58	365	187	9.92	896	389
P_3 64	4.194	13.44	389	145	14.34	1658	483	28.33	14.29	525	234	14.67	1498	600
K_2 60	3.086	14.61	414	157	18.72	2114	534	25.92	13.50	300	140	12.17	1228	435
K_3 240	0.000	14.79	415	185	16.59	1509	574	21.94	16.00	295	131	9.75	730	289
Ca_2 50	5.324	14.06	470	149	18.62	3306	729	32.73	16.67	384	138	22.33	1187	567
Ca_3 200	2.645	15.87	511	200	17.33	1750	550	34.84	15.50	340	139	14.50	2337	436
L.S.D.0.05	0.552	3.4	225	38	4.31	460	214	8.44	4.02	98.0	41.0	8.1	235	91.0

* Control I = Uninfested seeds grown in normal nutrient solution

**Control II = Infested seeds grown in normal nutrient solution.

was also associated with a reduction in all recorded data, except P_3 -level (64 ppm) which increased considerably all the recorded data in this respect.

3) The increase in K-level reduced the disease index to Zero % in K_3 (240 ppm) and this was associated with a reduction in almost all the other data as regards the resistant variety. Similar trend of results was noticed as regards the susceptible one.

4) Ca_2 level (50 ppm) increased greatly the disease index approximately twice that of Ca_3 (200 ppm) in the resistant variety, this was associated nearly with an increase in all other recorded data dealing with the shoot. As regards the susceptible variety the disease index was reduced slightly compared to control II and almost similar in both Ca_2 (50 ppm) and Ca_3 (200 ppm) levels except in case of the fresh weight of the shoot system that increased at Ca_3 (200 ppm) level.

Data in Table (6) and Fig.(3) lead to the following results:

1) The disease index increased almost four times that of the control (infested + normal solution) by increasing N level to N_4 (300 ppm) and little increase in root and shoot lengths could be noticed in the

resistant variety. Also, fairly high increases were noticed in fresh and dry weights of the root and shoot systems in case of the resistant variety. Similar result as regards disease index of the susceptible variety was noticed, however considerable increases were noticed at N_3 level (200 ppm) regarding other characters compared to control II.

2) As regards P element the increase in its level decreased greatly the disease index to reach Zero % at P_3 level (64 ppm) then increased to 1.5 times the control at P_4 level (96 ppm) in the resistant variety. In this respect it decreased the disease index of the susceptible variety particularly at both P_1(8 ppm) and P_4 (96 ppm) but it was increased at P_2 level (16 ppm).
The other data in the table were increased by the increase in P level in both the two varieties.

3) The increase in K level decreased the disease index of both varieties and reached Zero % with K_4 level (360 ppm) in the resistant variety. Also the other data increased with the increase in K-level in resistant and almost in susceptible varieties.

4) Generally, the disease index decreased with the increasing of Ca-levels. It decreased to Zero % at different levels after Ca_1 (25 ppm) in the resistant variety Giza 69 but it reached the highest percentage at Ca_3 level (200 ppm) then decreased afterwards in case of susceptible variety Giza 74.

The other data increased with the increase in Ca-level in both varieties.

Table (6): Effect of seed infestation with *F. oxysporum* f.sp. *vasinfectum* and macro-nutrient elements on disease index during 30 days after sowing and growth after 90 days from sowing of different cotton varieties in season 1980.

Treatment. ppm.	Different cotton varieties													
	Giza 69 (Resistant)							Giza 74 (Susceptible)						
	Disease index %	Root System			Shoot System			Disease index %	Root System			Shoot System		
		Ave. length cm.	Ave. fresh Wt.mg.	Ave. dry Wt.mg.	Ave. length cm.	Ave. fresh Wt.mg.	Ave. dry Wt.mg.		Ave. length cm.	Ave. fresh Wt.mg	Ave. dry Wt.mg	Ave. length cm.	Ave. fresh Wt.mg	Ave. dry Wt.mg
* Control I	0.00	9.51	714	272	11.10	1701	532	0.00	12.67	578	323	14.08	2384	719
** Control II	4.17	10.97	877	270	11.68	1818	570	12.5	13.33	317	317	10.40	2366	937
N_1 25	0.00	9.04	684	252	9.91	1662	462	0.00	14.17	636	242	15.00	2248	810
N_2 50	4.17	9.75	775	297	10.16	1794	602	5.55	13.67	702	315	15.04	2440	847
N_3 200	4.76	11.46	723	286	12.61	2505	591	5.55	14.17	1039	436	15.13	3096	1093
N_4 300	15.625	11.27	837	287	12.26	2572	589	10.41	14.83	946	398	15.81	3427	904
P_1 8	2.083	11.43	867	276	12.20	2382	648	6.25	13.00	825	343	14.08	2754	875
P_2 16	0.830	11.30	758	312	11.64	2233	704	16.66	11.33	898	399	13.31	3072	884
P_3 64	0.00	11.5	909	331	12.63	2648	814	12.27	17.67	1007	366	19.33	4250	1252
P_4 100	6.597	12.33	982	406	14.06	3144	833	0.00	20.33	1477	558	21.50	5126	1501
K_1 30	8.330	11.93	610	243	12.09	2453	727	40.26	12.67	739	290	14.00	2784	873
K_2 60	6.600	11.81	704	237	12.10	2472	650	20.83	16.50	912	343	16.88	4063	1216
K_3 240	3.470	11.10	702	282	11.98	2613	610	11.24	15.17	851	340	16.19	2885	978
K_4 360	0.000	11.82	893	370	12.48	2627	903	2.78	17.17	815	446	19.63	3852	1319
Ca_1 25	4.167	11.13	663	296	12.00	2227	560	16.66	16.17	525	321	16.13	2572	765
Ca_2 80	0.000	10.90	686	294	12.14	2136	547	16.67	13.08	530	247	14.50	2353	824
Ca_3 200	0.000	12.25	853	372	13.77	2800	705	49.98	16.00	662	263	16.75	2251	846
Ca_4 300	0.00	10.5	755	324	12.1	2401	592	29.16	14.83	732	328	15.63	2554	753
L.S.D.0.05	0.634	1.98	241	096	1.74	287	188	2.5	3.83	387	148	3.27	639	182

* Control I = Uninfected seeds grown in normal nutrient solution

** Control II = Infected seeds grown in normal nutrient solution.

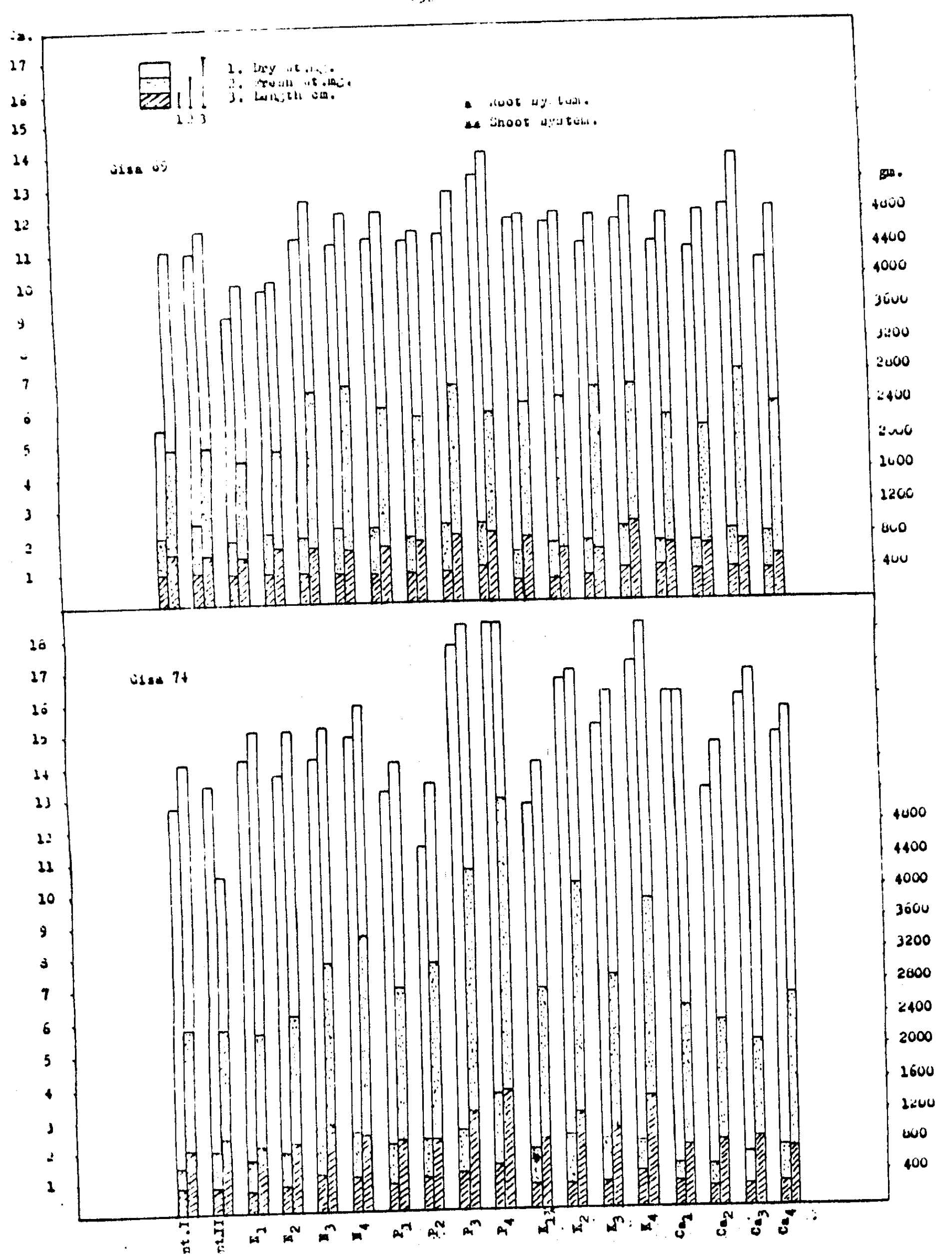


Fig.(3): Effect of seed infestation with F.oxysporum f.sp. vasinfectum and macro-nutrient elements on growth after 90 days from sowing of different cotton varieties in season 1980.

IV. The effect of seed infestation with *F.oxysporum* f.sp. *vasinfectum* spores and different micronutrients on both disease index (30 days after sowing) and plant growth (after 90 days) was tabulated in Table (7) for season (1979) and Table (8) for season (1980).

Data of Table(7) lead to the following results:-

1) Infestation caused growth reduction in the resistant variety while the opposite accurred in susceptible variety.

2) Zn_2-level increased the disease index almost two times of the control II(infested seeds)whereas the increase of Zn level to Zn_3(6 ppm) decreased it to almost the same level of control II.

As regards the different plant growth data, the increase in Zn-levels decreased them considerably compared to control II especially with Zn_3 level (6 ppm) as regards the resistant variety. Nearly similar results were noticed as regards the susceptible variety except that the fresh weight of the root system and both the fresh and dry weights of the shoot system increased in Zn_3 level (6 ppm).

3) Similar trends to Zn results were noticed in B-and Cu-levels of both varieties as regards disease index and decreasing all other data except length and fresh weight of shoot in cases of B_3(1 ppm) and Cu_2levels (0.05 ppm).

Table (7): Effect of seed infestation with <u>F. oxysporum</u> f.sp. <u>vasinfectum</u> and micronutrient elements on disease index during 30 days after sowing and plant growth after 90 days from sowing of different cotton varieties in Season 1979.

Treatment ppm.	Different cotton varieties													
	Giza 69 (Resistant)							Giza 74 (Susceptible)						
	Disease index %	Root System			Shoot System			Disease index %	Root System			Shoot System		
		Ave. length. cm.	Ave. fresh Wt.mg.	Ave. dry Wt.mg.	Ave. length cm.	Ave. fresh Wt.mg.	Ave. dry Wt.mg.		Ave. length cm.	Ave. fresh Wt.mg.	Ave. dry Wt.mg.	Ave. length cm.	Ave. fresh Wt.mg.	Ave. dry Wt.mg.
* Control I	0.00	16.49	602	241	15.41	1511	642	0.00	13.92	269	127	11.17	867	374
** Control II	2.76	17.00	499	189	15.46	1439	581	42.21	20.08	492	205	13.17	1225	457
Zn_2 1.5	4.167	12.83	327	135	12.79	1196	391	40.27	13.17	288	126	15.33	1217	398
Zn_3 6.0	2.153	12.58	255	92	13.70	1071	426	38.64	18.87	513	206	13.83	1749	567
B_2 0.25	10.555	14.20	335	123	14.20	1427	426	43.5	17.93	318	197	22.00	1951	584
B_3 1.0	3.472	14.33	347	129	16.04	1649	505	41.66	13.92	386	154	17.00	1711	489
Cu_2 0.05	3.315	15.24	452	177	18.08	1761	556	35.64	16.83	388	163	15.00	2010	576
Cu_3 0.20	0.694	13.00	333	132	16.87	1685	477	23.40	11.5	208	86	12.66	908	268
L.S.D. 0.05	0.452	N.S.	90.0	35.0	3.58	288	66	8.44	5.76	88	41	2.63	245	51.0

* Control I = Uninfested seeds grown in normal nutrient solution.

** Control II= Infested seeds grown in normal nutrient solution.

Data of Table (8) and Fig.(4) lead to the following results:-

1) In the resistant variety, the increase in Zn-levels from level one (0.75 ppm) to level two (1.5 ppm) decreased disease index to Zero % then increased at the third level (6 ppm) however, lower than the control (3 ppm) and was decreased to Zero % again at level Zn_4(9 ppm) while the disease index increased as Zn increased in the susceptible one.

2) B_2 level (0.25 ppm) decreased disease index to Zero percentage however, the other levels increased it slightly than control II. As regards almost all other data, noticed increases were recorded especially at B_3 level (1 ppm). This is true in the resistant variety. As for the susceptible, variety the increase in B level increased the disease index. Same trend of general growth as recorded before was noticed in all other data.

3) Cu different levels showed similar flactuation in growth and disease index as in B element.

4) Mn_2(0.25 ppm) and Mn_3(1 ppm) levels decreased the disease index to Zero %, but it increased greatly at Mn_4 level (1.5 ppm) as regards the resistant variety. However level Mn_3(1 ppm) decreased the disease

index in the susceptible variety to almost half it's amount but the increase to Mn_4 (1.5ppm) increased it again slightly more than the level of control (0.5 ppm). All the other data as regards both varieties increased by the increase in Mn level especially Mn_3 (1 ppm).

Table (8): Effect of seed infestation with **F.oxysporum** f.sp. **vasinfectum** and micronutrient elements on disease index during 30 days after sowing and growth after 90 days from sowing of different cotton varieties in season 1980.

Treatment ppm.	Different cotton varieties													
	Giza 69 (Resistent)							Giza 74 (Susceptible)						
	Disease index %	Root System			Shoot System			Disease index %	Root System			Shoot System		
		Ave. length. cm.	Ave. fresh Wt.mg	Ave. dry Wt.mg	Ave. length cm.	Ave. fresh Wt.mg.	Ave. dry Wt.mg.		Ave. length. cm.	Ave. fresh Wt.mg.	Ave. dry Wt.mg.	Ave. length cm.	Ave. fresh Wt.mg.	Ave dry Wt.mg.
* Control I	0.00	5.51	714	272	11.10	1701	532	0.00	12.67	578	323	14.08	2384	719
** Control II	4.17	10.97	877	270	11.68	1818	570	12.50	13.33	760	317	10.40	2366	937
Zn_1 0.75	1.389	11.77	797	310	12.97	2643	654	4.17	13.33	753	369	15.25	2713	927
Zn_2 1.5	0.00	11.82	665	281	13.04	2373	607	12.5	17.00	888	467	17.50	3417	1126
Zn_3 6.0	3.47	13.50	794	308	14.42	2806	739	15.27	15.67	747	311	17.00	2705	862
Zn_4 9.0	0.00	11.33	497	210	12.06	2271	570	17.35	15.50	835	360	15.75	2962	969
B_1 0.125	5.208	11.67	729	293	12.56	2548	619	29.16	16.92	628	291	15.69	3184	954
BB_2 0.250	0.00	11.73	660	271	13.05	2048	624	20.83	17.00	700	350	16.88	2936	945
B_3 1.00	5.26	14.07	722	298	14.66	2482	735	20.13	15.00	712	407	15.63	3165	1039
B_4 1.50	5.208	13.20	621	259	14.04	2494	685	14.58	16.75	809	421	17.82	3060	971
Cu_1 0.025	4.167	13.97	701	299	14.30	2597	731	83.39	21.00	711	422	22.5	3904	1208
Cu_2 0.05	2.98	11.97	686	316	13.75	2421	666	19.44	16.00	565	344	17.56	3151	1076
Cu_3 0.200	5.56	12.67	678	363	13.35	2431	662	9.72	19.33	843	488	18.13	3171	1091
Cu_4 0.300	4.167	11.53	531	329	12.75	2484	670	11.11	17.33	594	329	18.44	3161	1017
Mn_1 0.125	5.208	13.13	678	358	14.06	2314	653	19.231	15.93	835	326	17.33	2949	901
Mn_2 0.25	0.00	11.23	666	319	12.62	2128	581	17.86	17.83	1178	534	19.06	3403	1104
Mn_3 1.00	0.00	13.43	637	332	14.43	2874	773	6.41	16.92	865	381	19.90	2923	968
Mn_4 1.5	16.67	11.43	839	423	13.54	2416	769	13.89	15.67	1301	604	17.69	3541	1128
L.S.D. 0.05	1.13	1.66	244	115	1.74	302	104	3.05	4.79	415	161	4.04	608	255

* Control I = Uninfested seeds grown in normal nutrient solution.

** Control II = Infested seeds grown in normal nutrient solution.

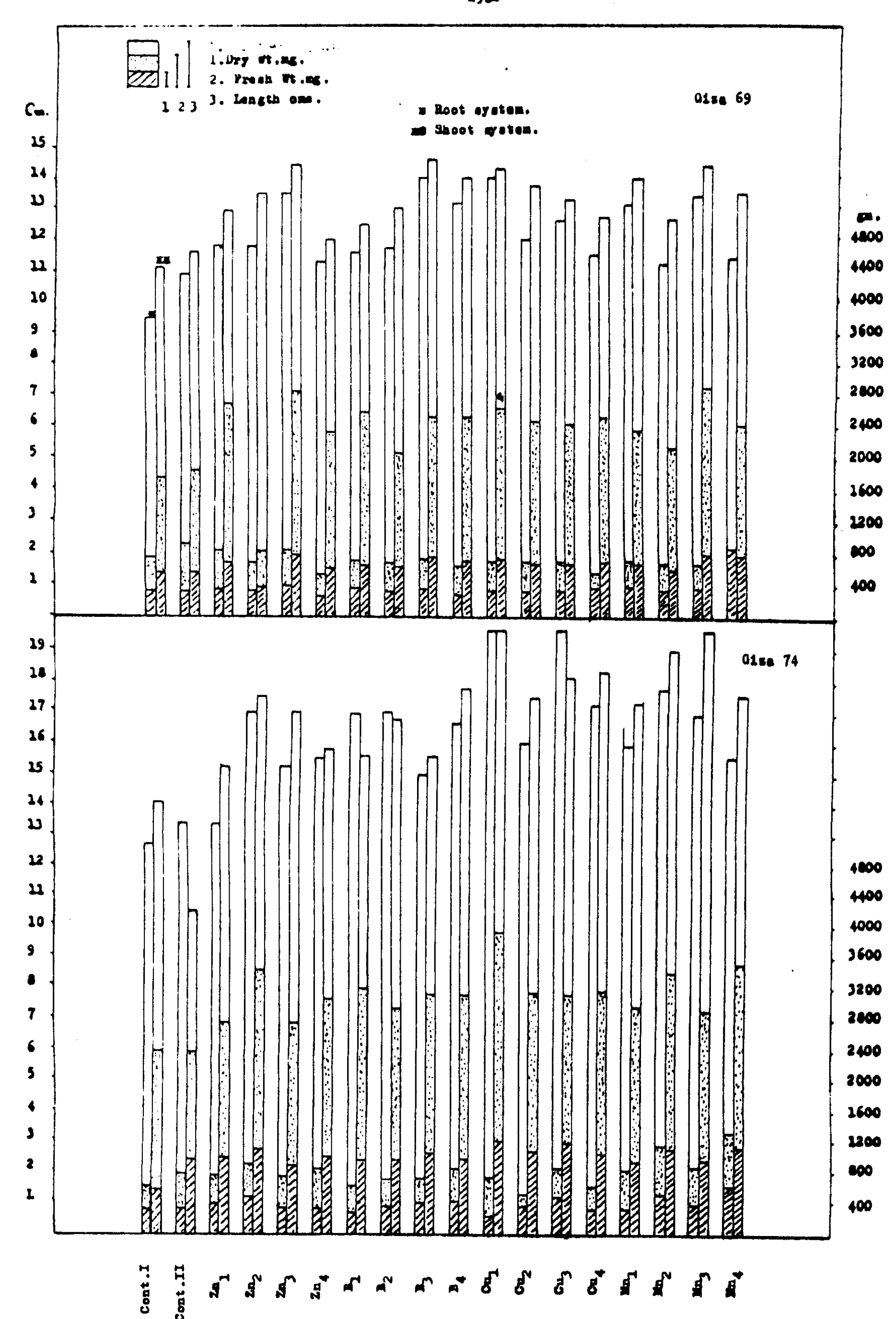


Fig.(4): Effect of seed infestation with F.oxysporum f.sp. vasinfectum and micro-nutrient elements on growth after 90 days from sowing of different cotton varieties in season 1980.

V- The effect of seed infestation with spores of *F. oxysporum* f.sp. *vasinfectum* on sugars contents, phenolic compounds and total amino acids of two cotton varieties, as affected with N,P,K, and Ca macronutrients. Results are recorded in Table (9).

Data of Table (9) and Fig.(5) lead to the following results:-

1) The increase in N level decreased the percentage of healthy survivals, however these percentages almost were more than control II level, in both the resistant and susceptible varieties.

As regards sugar contents, reducing sugars increased in levels N_1 (25 ppm) and N_2 (50 ppm) then decreased and become similar to that of control II (100 ppm) at level N_3 (200 ppm) then increased considerably at level N_4 (300 ppm) in the resistant variety.

A great reduction in non-reducing sugars was noticed by increasing N level. However, total sugars decreased compared to control II with all the different levels especially N_4(300 ppm).

On the other hand the increase in N level increased the percentage of healthy survivals in case of the susceptible variety, however a gradual reduction was noticed by increasing N level.

2) As regards P level it increased the healthy survivals at all levels especially levels P_2 (16 ppm) and P_4 (100 ppm) in the resistant variety. In this respect little increases were noticed at all levels except P_3 (64 ppm) which reduced the percentage of healthy survivals greatly.

Also, the total sugars were reduced than control II on contrast with reducing sugars with the increase in P levels, however a gradual reduction in it's percentage was noticed especially P_4 (100 ppm), in reasistant variety. In this respect similar trend of results was noticed as regards the susceptible variety. Same trend was noticed also as regards the phenolic compounds in both varieties, however the percentages of free phenols was much lower in the susceptible than resistant variety.

3) As regards K levels similar trend as P-levels was noticed in the percentages of healthy survivals and reduced sugars in the resistant variety.

On the other hand the percentages of healthy survivals decreased greatly at level K_1 (30 ppm) then increased by increasing K, same trend was noticed as regards reduced sugars in the susceptible variety. As for free phenols, their percentage increased gradually till level K_3 (240 ppm) then was reduced greatly at K_4 level (360 ppm).

4) The increase in Ca level to levels Ca_2 (50 ppm) and Ca_3 (200 ppm) increased the percentage of healthy survivals then decreased at Ca_4 (300 ppm) however it remained higher than the control in the resistant variety. As regards the weight of reduced sugars it increased at Ca_1 level (25 ppm) then decreased gradually till Ca_3 level (200 ppm) then increased again at Ca_4 level (300 ppm). On the other hand the weight of free phenols increased with the increase in Ca level till it reched its maximum at Ca_4 level (300 ppm). As for the susceptible variety the percentage of healthy survivals decreased at Ca_1 level (25 ppm) then increased

greatly at levels Ca_2(50 ppm) and Ca_3 (200 ppm) but a great drop was noticed at Ca_4 level (300 ppm). Also, the concentration of free phenols decreased gradually by the increase in Ca in the same variety (susceptible).

5) It is noticed clearly that total and reduced sugars and free phenols amounts were more in the susceptible variety than the resistant one.

6) Compared with control II all treatments reduced total amino acids in the resistant variety except P_3, K_3 and Ca_2 levels. With regards to the susceptible variety all treatments increased total amino acids except N_1(25 ppm), N_3(200 ppm), P_1(8 ppm) and Ca_4 (300 ppm).

Table (9): Effect of seed infestation with F.oxysporum f.sp. vasinfectum levels of macronutrient elements on healthy survival plants, sugars, phenolic compounds and total amino acids in cotton varieties Giza 69 and Giza 74 after 45 days from sowing in season 1980.

Treatment ppm	Giza 69 (Resistant)								Giza 74 (Susceptible)							
	Surv-ivals %	gm/100 gm fresh weight						Total amino acids	Surv-ivals %	gm/100 gm fresh weight						Total amino acids
		Sugars			Phenolic compounds					Sugars			Phenolic compounds			
		Redus-ing	Non-reducing	Total	Free	Conjug-ated	Total			Redus-ing	Non-reducing	Total	Free	Conjug-ated	Total	
* Control I	96.49	6.32	5.52	11.84	6.81	0.94	1.75	9.47	92.86	9.69	2.94	12.64	1.13	0.15	1.28	17.37
** Control II	52.14	3.71	5.89	9.60	1.58	0.22	1.80	8.42	40.24	7.08	3.93	11.00	0.85	2.28	3.13	6.32
N_1 25	64.29	7.30	2.58	9.88	1.71	0.88	2.59	6.84	53.57	7.73	2.45	10.18	0.90	1.02	1.92	5.26
N_2 50	64.29	7.67	0.98	8.65	1.19	0.31	1.5	7.89	53.57	7.89	3.93	11.82	1.40	0.15	1.55	4.21
N_3 200	62.88	3.74	0.74	4.48	1.08	0.30	1.38	7.89	46.43	6.27	4.24	10.51	0.98	0.21	1.99	2.11
N_4 300	50.36	4.60	0.74	5.34	0.98	0.27	1.25	7.37	42.86	5.28	1.31	6.59	0.33	0.36	0.70	8.42
P_1 8	65.18	5.71	1.72	7.42	1.25	0.36	1.61	7.37	41.67	7.24	3.11	10.35	0.83	0.42	1.25	5.79
P_2 16	75.00	7.55	0.62	8.16	1.36	0.06	1.42	6.32	43.75	5.93	3.27	9.20	0.69	0.61	1.29	7.89
P_3 64	64.29	5.58	3.56	9.14	1.08	0.30	1.38	8.95	29.03	5.93	4.25	10.18	0.70	0.70	1.40	6.32
P_4 100	72.32	4.85	0.37	5.21	0.94	0.14	1.08	7.37	42.86	4.62	3.25	7.87	0.67	0.71	1.38	7.37
K_1 30	70.83	5.46	3.68	9.14	0.50	0.48	0.98	6.84	22.62	5.77	3.60	9.37	0.66	0.64	1.29	10.53
K_2 60	62.26	4.72	3.07	7.79	0.88	0.06	0.94	9.47	39.29	5.77	3.43	9.20	0.79	0.46	1.25	8.95
K_3 240	67.86	3.93	3.50	7.42	1.02	1.42	2.38	5.79	50.00	8.22	4.58	12.80	1.54	0.50	2.04	7.37
K_4 360	71.43	4.48	0.98	5.46	1.02	0.48	1.50	7.89	64.29	7.73	3.44	11.17	0.25	2.50	3.75	7.37
Ca_1 25	52.97	5.21	1.23	6.44	0.53	0.32	0.86	6.84	38.99	8.55	3.27	11.82	1.02	1.50	2.50	6.84
Ca_2 50	78.57	4.97	2.95	7.91	0.59	0.37	0.96	8.95	53.57	4.87	1.86	6.74	0.73	1.27	2.00	7.89
Ca_3 200	76.57	3.87	2.45	6.32	1.06	0.34	1.42	5.25	60.71	8.71	2.78	11.49	0.62	0.76	1.38	10.53
Ca_4 300	60.71	6.44	4.91	11.35	1.42	0.04	1.46	7.37	18.46	5.77	4.91	10.67	0.68	1.41	2.09	5.79
L.S.D.0.05	11.54	-	-	-	-	-	-	-	8.05	-	-	-	-	-	-	-

* Control I = Uninfested seeds grown in normal nutrient solution.

** Control II = Infested seeds grown in normal nutrient solution.

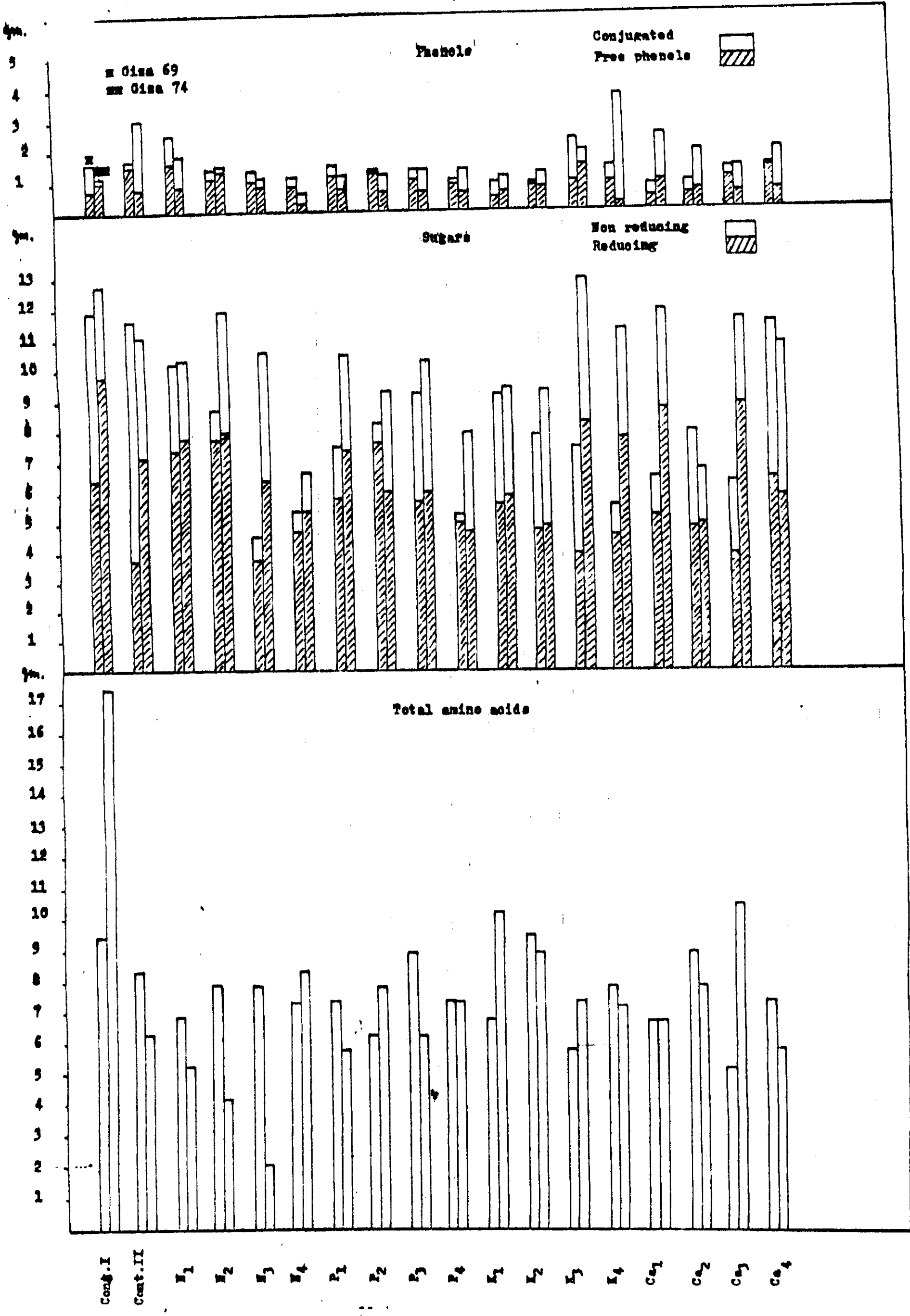


Fig.(5): Effect of seed infestation with *F. oxysporum* f.sp. *vasinfectum* levels of macronutrient elements on sugars, phenolic compounds and total amino acids in cotton varieties Giza 69 and Giza 74 after 45 days from sowing in season 1980.

VI- The effect of seed infestation with spores of *F. oxysporum* f.sp. *vasinfectum* on sugars contents and phenolic compounds of two cotton varieties as affected with Zn, B, Cu and Mn micronutrients. Results were recorded in Table (10).

Data of table (10) and Fig (6) lead to the following results:-

1) The percentage of healthy survivals increased by applying different levels of all tested micronutrients than control II except the highest level of Mn (Mn_4 1.5 ppm) which was reduced sharply.

As regards Zn levels, the highest percentages of healthy survivals were obtained at Zn_1 (0.75 ppm) and Zn_2 (1.5 ppm) levels, then a clear reduction is noticed at Zn_3 (6 ppm) then increases again at the highest level of Zn_4 (9 ppm) in case of the resistant variety and a considerable increase was noticed in case of the susceptible variety.

, As regards B element the percentage of healthy surivals increased by increasing B levels. Same trend was noticed in case of Cu element in case of the resistant variety, however little increases.

Were noticed as regards the susceptible variety Mn_1 (0.125 ppm) and Mn_3 (1 ppm) levels showed the highest percentages of healthy survivals, however Mn_2 (0.25 ppm) decreased it to almost the level of control II but Mn_4 level (1.5 ppm) gave the lowest percentages in this respect in both the resistant and susceptible varieties.

2) Generally, total sugars content was reduced by different treatments in the resistant variety, on contrast with the susceptible one on the other hand reduced sugars showed reverse results.

3) As regards the phenolic compounds, general reduction in total phenols in both varieties was noticed except in case of Zn_4 (9 ppm), B_1(0.125 ppm) and Cu_1 (0.025 ppm) as regards the resistant variety and Zn_2 (1.5 ppm), Zn_4 (9 ppm) in the susceptible variety. Free phenols levels were generally higher than the control in the susceptible variety on contrest with the resistant one.

4) Total amino acids were decreased in different treatments of the susceptible variety and the resistant one exception in case of B_3 (1 ppm), Cu_4((0.3 ppm) and Mn_2 (0.25 ppm) levels.

Table (10): **Effect of seed infestation with F.oxysporum f.sp. vesinfectum and different levels of micronutrients elements on healthy survival plants, sugars, phenolic compounds and total amino acids in cotton leaves varieties Giza 69 and Giza 74 after 45 days from sowing in season 1980.**

Treatment ppm	Different cotton varieties															
	Giza 69 (Resistant)								Giza 74 (Susceptible)							
	Surv-ivals %	gm/100 gm fresh weight						Total amino asids	Surv-ivals %	gm/100 gm fresh weight						Total amino acids
		Sugars			Phenolic compounds					Sugars			Phenolic compounds			
		Redus-ing	Non-reducing	Total	Free	Conjug-ated	Total			Redus-ing	Non-reducing	Total	Free	Conjug-ated	Total	
* Control I	96.49	6.32	5.52	11.84	0.81	0.94	1.75	9.47	92.86	9.69	2.94	12.64	1.13	0.15	1.28	17.37
** Control II	52.14	3.71	5.89	11.59	1.56	0.22	1.8	8.42	40.24	7.08	3.92	11.00	0.85	2.28	3.13	6.32
Zn_1 0.75	82.14	5.21	2.45	7.67	0.49	0.45	0.94	6.84	42.86	6.09	5.89	11.98	1.04	0.58	1.63	8.42
Zn_2 1.50	82.14	4.85	3.56	8.4	1.29	0.04	1.33	6.32	50.00	6.25	3.44	9.69	0.92	2.84	3.75	14.74
Zn_3 6.00	58.71	5.21	3.19	8.4	1.06	0.23	1.29	7.89	51.79	6.75	5.89	12.64	1.15	0.54	1.69	7.89
Zn_4 9.00	75.00	6.20	2.33	8.53	1.54	0.21	1.75	6.32	50.00	5.28	4.91	10.18	1.19	2.57	3.75	6.84
B_1 0.125	61.61	5.83	1.84	7.67	1.15	0.94	2.09	8.95	57.14	7.4	5.24	12.64	1.33	1.17	2.5	8.42
B_2 0.250	64.41	5.09	4.17	9.26	1.02	0.36	1.38	7.89	42.32	6.26	6.54	12.80	1.08	1.00	2.09	8.95
B_3 1.00	73.33	4.85	3.13	8.16	0.68	0.32	1.00	14.74	46.43	7.7	5.60	13.29	0.88	0.17	1.04	10.00
B_4 1.50	75.0	5.58	1.60	7.18	0.54	0.12	0.66	6.84	50.00	6.09	6.71	12.8	0.79	0.38	1.17	6.32
Cu_1 0.025	54.83	4.97	2.45	7.42	1.25	0.92	2.17	7.37	28.67	6.42	3.44	9.86	1.21	0.42	1.163	7.37
Cu_2 0.05	96.16	3.62	1.96	5.58	1.00	0.50	1.5	4.21	46.43	4.62	3.76	8.38	1.46	0.08	1.54	10.53
Cu_3 0.200	65.83	4.85	3.13	8.16	1.11	0.27	1.38	9.47	40.24	5.60	2.62	8.22	0.58	0.90	1.48	6.84
Cu_4 0.300	67.26	5.46	0.61	6.07	1.25	0.13	1.38	11.05	46.43	5.77	2.29	8.06	0.53	0.43	0.96	7.89
Mn_1 0.125	71.43	6.20	2.7	8.9	0.73	0.37	1.11	5.79	55.71	4.46	2.21	6.67	0.77	0.15	0.92	7.37
Mn_2 0.250	53.57	4.97	2.21	7.18	0.98	0.35	1.33	13.16	49.89	5.44	1.64	7.08	0.46	0.40	0.84	9.47
Mn_3 1.00	75.89	6.20	2.58	8.77	1.21	0.25	1.46	6.32	47.32	6.42	2.45	8.87	0.99	0.27	1.25	7.89
Mn_4 1.50	23.21	5.71	3.80	9.51	0.65	0.56	1.21	5.79	38.99	5.77	0.98	6.75	0.97	0.17	1.04	6.32
L.S.D.0.05	20.43	-	-	-	-	-	-	-	8.03	-	-	-	-	-	-	-

* Control I = uninfested seeds grown in normal nutrient solution.

** Control II = Infested seeds grown in normal nutrient solution.

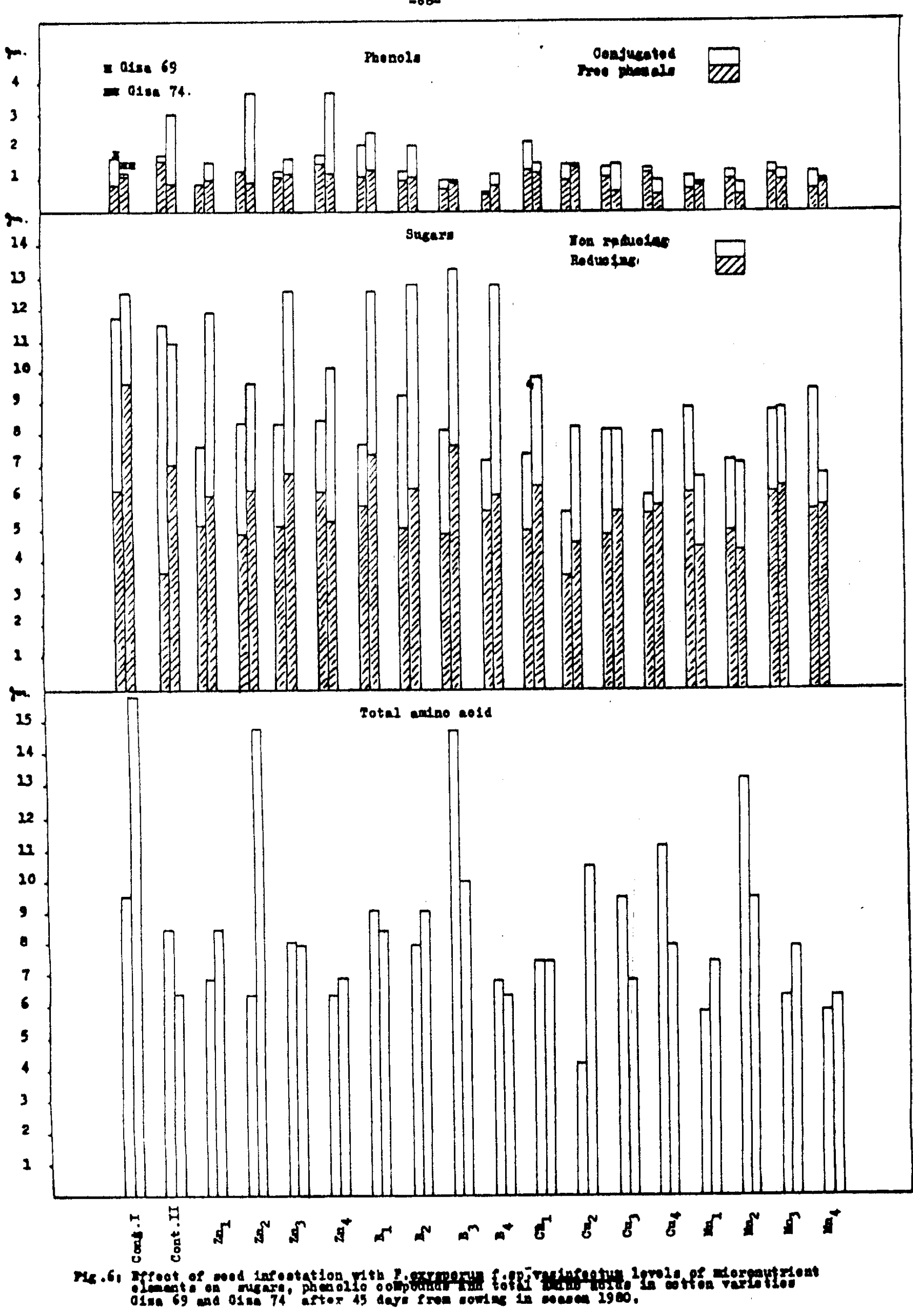


Fig.6: Effect of seed infestation with F.oxysporum f.sp. vasinfectum levels of micronutrient elements on sugars, phenolic compounds and total amino acids in cotton varieties Giza 69 and Giza 74 after 45 days from sowing in season 1980.

vii- The effect of seed infestation with spores of *F. oxysporum* f.sp. rasinfectum and different levels of macro-nutrients on disease index and leaf pigments(chloropylls and carotenoids) was recorded. Results are tabulated in Tables (11) and (12) for season 1979 and 1980 respectively.

Data in Table (11) lead to the following results:

1) Plants raised from intested seed showed consistent decrease in all pigments detected with the exception of xanthophylls. This is true in both resistant & susceptible varieties. The increase noticed in xanthophylls failed to offest the decrease in total carotenoids in both varieties.

2) Total chlorophylls, chlorophyll a and b and xanthophyll increased in all treatments in case of the resistant variety compared to control II. Contrast results were obtained as regards the carotene except in case of the resistant variety. In case of total carotenoids its amounts increased by increasing P , K and Ca whereas the contrast was noticed as regards N element. Similar results were obtained as regards

Table (11) Effect of seed infestation with F. oxysporum f.sp. vasinfectum and different levels of macronutrient elements on disease index and leaf pigments of different cotton varieties Giza 69 and Giza 74 after 45 days from sowing in season 1979.

Treatment ppm.	Different cotton varieties													
	Giza 69 (Resistant)							Giza 74 (Susceptible)						
	Disease index %	Mg/gm fresh weight						Disease index %	Mg/gm fresh weight					
		Chlorophylls			Carotenoids				Chlorophylls			Carotenoids		
		Chlorophyll a	Chlorophyll b	Total chlorophylls	Carotene	Xanthophyll	Total Carotenoids		Chlorophyll a	Chlorophyll b	Total chlorophylls	Carotene	Xanthophyll	Total Carotenoids
* Control I	0.00	0.549	0.189	0.738	0.309	0.019	0.328	0.00	0.540	0.160	0.700	0.102	0.146	0.124
** Control II	2.76	0.466	0.105	0.571	0.270	0.036	0.306	42.21	0.492	0.159	0.651	0.076	0.160	0.118
N_2 50	3.208	0.525	0.129	0.654	0.279	0.078	0.357	28.33	0.627	0.180	0.807	0.098	0.116	0.214
N_3 200	5.556	0.847	0.225	1.072	0.024	0.298	0.222	32.73	0.823	0.250	1.073	0.130	0.158	0.288
P_2 16	3.58	0.651	0.267	0.918	0.070	0.494	0.564	11.11	0.461	0.123	0.584	0.074	0.094	0.17
P_3 64	4.194	0.814	0.258	1.072	0.088	0.654	0.742	28.33	0.615	0.192	0.807	0.092	0.146	0.238
K_2 60	3.086	0.520	0.162	0.682	0.052	0.102	0.154	25.92	0.529	0.154	0.683	0.064	0.116	0.180
K_3 240	0.00	0.773	0.243	1.016	0.11	0.164	0.274	21.94	0.675	0.180	0.835	0.086	0.144	0.230
Ca_2 50	5.324	0.751	0.223	0.974	0.08[illegible]	0.296	0.384	32.73	0.810	0.219	1.029	0.066	0.150	0.216
Ca_3 200	2.645	0.974	0.292	1.266	0.46	0.168	0.628	34.84	0.453	0.147	0.600	0.090	0.090	0.180
L.S.D. 0.05	0.5[illegible]2	-	-	-	-	-	-	8.44	-	-	-	-	-	-

* Control I = Uninfested seed grown in normal nutrient solution.

** Control II = Infested seeds grown in normal nutrient solution.

chlorophyll amounts in the susceptible variety except Ca_3 level (200 ppm) of chlorophyll a or b and total chlorophylls. Also carotene amounts increased in all treatments except P_2 (16 ppm), K_2 (60 ppm) and Ca_2 (50 ppm) levels. However, xanthophyll amounts were decreased in all treatments. Total carotenoids increased in all treatments.

Data in table (12) and Fig(7) lead to the following results.

1) All pigments detected recorded lower values due to infestation in both varieties with the exception of carotene in the resistant variety and xanthophyll in both varieties. However the total carotenoids follwed the normal behaviour as the other chlorophylls.

only and reached Zero percent at K_4 level (360 ppm) in case of the resistant variety.

2) Ca_1 level (25 ppm) gave similar disease index as the control then a great reduction was noticed as it reached Zero percent. with the other levels in case of the resistant variety. On the other hand, the percentage of disease index increased greatly at Ca_3 level (200 ppm) then reduced at Ca_4 level (300 ppm) however, the percentage was nearly 2.5 times that of the control as regards the susceptible variety.

3) General decrease in chlorophyll a and b and total chlorophylls was noticed by increasing the levels of N except N_2 level (50 ppm) which was similar to control II as regards the resistant variety. Reverse results in this respect could be noticed as regards the susceptible variety.

Contrast results are noticed as regards caroten except N_1 level (25 ppm) of the resistant variety and N_4 (300 ppm) of the suceptible one. As regards xanthophyll great decrease is noticed as compared with control II in both varieties.

4) No clear differences in chlorophyll a and b and total chlorophylls than control II as affected with P in the resistant variety were noticed. While P increased these pigments in the susceptible variety especially at P_1 level (8 ppm).

As regards carotene great increase was noticed in the resistant variety as affected by P levels especially P_3 level (100 ppm) on contrast with xanthophyll. On the other hand carotene and xanthophyll were reduced greatly in the susceptible variety.

5) K levels increased chlorophyll a and decreased chlorophyll b except K_2 level in the resistant variety. Also carotene was increased except K_3 level (240 ppm). Xanthophyll was increased at levels K_2 (60 ppm) and K_4 (360 ppm) levels.

As regards the susceptible variety all K levels increased chlorophyll a and b especially K_1 (30 ppm) and K_4 (360 ppm) levels. As for carotene K_1 (30 ppm) and K_3 (240 ppm) increased it greatly whereas K_2 (60 ppm) and K_4 (360 ppm) decreased it considerably.

it greatly, whereas K_1 (30 ppm) and K_4 (360 ppm) increased xanthophyll and level K_2 (60 ppm) decreased it considerably and greatly with K_3 level (240 ppm) in the susceptible vareity.

6) However, all the treatments decreased the total carotenoids and increased the chlorophylls in the susceptible variety.

7) Ca_1 level (25 ppm) increased chlorophyll a and b and total chlorophyll then a reduction is noticed by increasing Ca levels in the resistant variety.General increase is noticed also by different Ca levels in chlorophyll a and b and also xanthophyll except in Ca_4 level (300 ppm). The total carotenoids increased also except in Ca_4 level (300 ppm).As for the susceptible variety no differences could be noticed in chlorophyll a as affected with Ca levels except the increase in case of Ca_3. However chlorophyll b increased in all levels of Ca.Generally, the total chlorophyll increased as affected with all levels of Ca in the susceptible variety.The referse was noticed with caroten. In this respect a great reduction was noticed in caroten at levels Ca_3

(200 ppm) and Ca_4 (300 ppm) and at all the levels of Ca except Ca_3 (200ppm) in case of xanthophyll.

Table (12) Effect of seed infestation with P.oxysporum f.sp. vasinfectum and different levels of macronutrient elements on disease index and leaf pigments of didfferent cotton varieties Giza 69 and Giza 74 after 45 days from sowing in season 1980.

Treatment ppm.	Different cotton varieties													
	Giza 69 (Resistant)							Giza 74 (Susceptible)						
	Disease index %	Mg/gm fresh weight						Disease index %	Mg/gm fresh weight					
		Chlorophylls			Carotenoids				Chlorophylls			Carotenoids		
		Clorophyll a	Chlorophyll b	Total chlorophylls	Carotene	Xanthophyll	Total Caretenoids		Chlorophyll a	Chlorophyll b	Total chlorophyll	Carotene	Xanthophyll	Total Caretenoids
* Control I	0.00	0.945	0.307	1.252	0.199	0.083	0.282	0.00	0.845	0.280	1.225	0.118	0.061	0.179
** Control II	4.167	0.897	0.272	1.169	0.148	0.114	0.262	12.5	0.571	0.188	0.649	0.176	0.449	0.625
N_1 25	0.00	0.425	0.132	0.557	0.073	0.048	0.121	0.00	0.847	0.225	1.072	0.147	0.150	0.297
N_2 50	4.17	0.897	0.286	1.183	0.199	0.086	0.285	5.55	0.773	0.229	1.002	0.128	0.108	0.236
N_3 200	4.76	0.672	0.232	0.904	0.184	0.085	0.307	5.55	0.927	0.298	1.225	0.167	0.177	0.344
N_4 300	15.625	0.566	0.172	0.738	0.156	0.073	0.229	10.41	1.084	0.335	1.419	0.181	0.213	0.394
P_1 8	2.083	0.900	0.269	1.164	0.187	0.108	0.295	6.25	1.051	0.285	1.336	0.147	0.177	0.324
P_2 16	0.83	0.749	0.211	0.960	0.176	0.099	0.275	16.66	0.884	0.243	1.127	0.140	0.141	0.281
P_3 64	0.00	0.937	0.274	1.211	0.195	0.112	0.307	12.27	0.814	0.216	1.03	0.125	0.151	0.276
P_4 100	6.597	0.845	0.240	1.085	0.164	0.121	0.285	0.00	0.906	0.263	1.169	0.146	0.137	0.283
K_1 30	8.330	0.952	0.189	1.441	0.243	0.028	0.271	40.26	1.01	0.312	1.322	0.184	0.145	0.329
K_2 60	6.600	0.915	0.285	1.28	0.161	0.183	0.344	20.83	0.808	0.222	1.03	0.125	0.120	0.245
K_3 240	3.47	0.924	0.217	1.141	0.131	0.100	0.231	31.24	0.877	0.348	1.225	0.249	0.067	0.316
K_4 360	0.00	1.046	0.234	1.28	0.156	0.134	0.290	2.78	1.416	0.258	1.614	0.014	0.508	0.522
Ca_1 25	4.167	[illegible]	0.320	1.419	0.161	0.118	0.279	16.66	0.840	0.287	1.127	0.167	0.101	0.268
Ca_2 50	0.00	0.71	0.226	0.946	0.175	0.118	0.293	16.67	0.859	0.254	1.113	0.156	0.131	0.287
Ca_3 200	0.00	0.897	0.272	1.169	0.170	0.154	0.324	44.98	1.099	0.32	1.419	0.015	0.415	0.430
Ca_4 300	0.00	0.783	0.235	0.918	0.156	0.053	0.209	29.16	0.839	0.243	1.072	0.063	0.126	0.189
L.S.D.0.05	0.834	-	-	-	—	-	-	2.5	-	-	-	-	-	-

* Control I = uninfested seeds grown in normal nutrient solution.

** Control II = Infested seeds grown in normal nutrient solution.

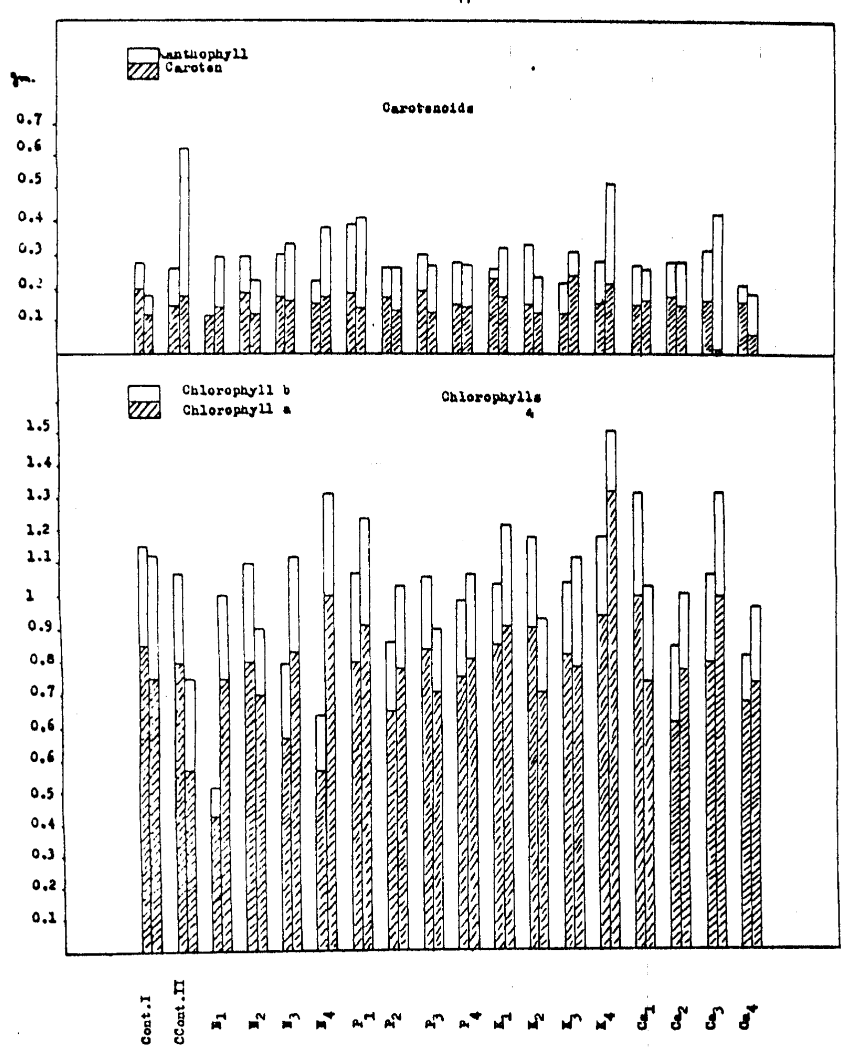


Fig.:(7) Effect of seed infestation with F. oxysporum f.sp. vasinfectum and different levels of macronutrient elements on leaf pigments of different cotton variaties Gisa 69 and Gisa 74 after 45 days from sowing in season 1980.

Cont.I = Uninfested seeds grown in normal nutrient solution.
Cont.II= Infested seeds grown in normal nutrient solution.

VII- The effect of seed infestation with spores of <u>F. oxysporum</u> f.sp. <u>vasinfectum</u> and different levels of micronutrient elements on disease index and leaf pigments (chlorophylls and carotenoids) of different cotton varieties Giza 69 and Giza 74 is recorded in Tables (13) and (14) for season 1979 and 1980 respectively.

Data in Table (13) lead to the following results:-

1) Infestation resulted in noticeable in all leaf pigments with the exception of xanthophyll in resistant variety and carotene and xanthophyll in susceptible one.

2) Comparing with control II, all the micro elements increased chlorophylls a and b and the total chlorophylls. The reverse was noticed as regards carotene except Cu_2 level (0.05 ppm), whereas great increases were noticed in xanthophyll in the resistant variety. Similar increases in chlorophylls were noticed in the susceptible variety except in case of Zn_2 (1.5 ppm), B_3 (1 ppm) and Cu_3 (0.2 ppm) with chlorophyll a only. In case of carotene, it was increased in case of Zn_3 (6 ppm) and Cu_2 (0.05 ppm). As for xanthophyll generally it decreased greatly in Zn_2 (1.5 ppm) and Cu_3 (0.2 ppm) levels.

Table (13): Effect of seed infestation with F.oxysporum f.sp. vasinfectum and different levels of micronutrient elements on disease index and leaf pigments of different cotton varieties Giza 69 and Giza 74 after 45 days from sowing in season 1979.

Treatment ppm.	Different cotton varieties													
	Giza 69 (Resistant)							Giza 74 (Susceptible)						
	Disease index %	Mg/gm fresh weight						Disease index %	Mg/gm fresh weight					
		Chloropylls			Carotenoids				Chlorophylls			Carotenoids		
		Caloroph-yll a	Chloroph-yll b	Total chlor-ophylls	Carotene	Xantho-phyll	Total Carot-enoids		Chloro-phyll a	Chloro-phyll b	Total chlor-ophylls	Carotene	Xantho-phyll	Total Carot-enoids
* Control I	0.00	0.549	0.189	0.738	0.309	0.019	0.328	0.00	0.540	0.160	0.700	0.102	0.146	0.124
** Control II	2.76	0.466	0.105	0.571	0.270	0.036	0.306	42.21	0.492	0.159	0.651	0.076	0.160	0.118
Zn_2 1.5	4.167	0.782	0.234	1.016	0.086	0.146	0.232	40.27	0.471	0.169	0.640	0.104	0.80	0.184
Zn_3 6.0	2.183	0.893	0.243	1.127	0.140	0.370	0.384	38.69	0.787	0.243	1.03	0.040	0.138	0.178
B_2 0.25	10.555	0.959	0.321	1.28	0.102	0.164	0.266	43.50	0.785	0.255	1.04	0.094	0.160	0.254
B_3 1.00	3.472	0.778	0.238	1.016	0.066	0.132	0.198	41.66	0.200	0.342	1.542	0.090	0.164	0.254
Cu_2 0.05	3.315	0.828	0.261	1.099	0.464	0.282	0.746	35.64	0.559	0.223	1.002	0.068	0.136	0.204
Cu_3 0.20	0.694	0.897	0.272	1.169	0.070	0.150	0.218	23.40	0.407	0.360	0.767	0.140	0.024	0.164
L.S.D.0.05	0.452	-	-	-	-	-	-	8.44	-	-	-	-	-	-

* Control I = Uninfested seeds grown in normal nutrient solution.

** Control II= Infested seeds grown in normal nutrient solution.

Data in table (14) and Fig (8) lead to the following results:-

a) <u>The resistant variety:-</u>

1) Plants of infested seeds gave lower values of leaf pigments compared with the uninfested ones with the exception of xanthophyll in resistant variety and carotenoids in the susceptible one.

2) Chlorophyll a amounts increased in all treatments than control II except B_3 (1 ppm) and Cu_1 (0.025) ppm) which showed slight reduction. Similar trend was noticed in case of chlorophyll b and total chlorophylls compared to control II.

3) As regards carotene, general decrease is noticed in all treatments especially Cu_4 (0.3 ppm), B_3 (1 ppm) and Cu_3 (0.2 ppm). However Zn_4 (1.5 ppm), B_1 (0.125 ppm), B_2 (0.25 ppm), Mn_1 (0.125 ppm), and Mn_3 (100 ppm) showed considerable increase than control only. Contrast trend is noticed in case of xanthophyll and considerable increases

could be noticed especially Cu_4 and Zn_1 followed by Zn_4 (9 ppm), B_1 (0.125 ppm) and B_2 (0.25 ppm).

b) The susceptible variety:

1) The disease index increased considerably in control II compared with control I. The increasing levels of Zn increased disease index on contrast with the other micro-elements B, Cu and Mn. However the highest diseasc index was in Cu_1 (0.025 ppm) level as it reached 83.3% and the lowest one was Zero level in control I.

2) Chlorophyll a decreased in control II compared with control I. General increase in chlorophyll a was noticed in different treatments compared to control II reached its maximum in B_3 level (1.0 ppm). Similar trend was noticed as regards chlorophyll b, however, the highest amounts were noticed at Zn_2 (1.5 ppm), Zn_3 (16 ppm) and B_3 (1 ppm) levels.

3) As regards carotene its amount increased in control II than control I. However, general decrease could be noticed by different treatments except B_4 (1.5 ppm), Mn_3 (1.0 ppm) Mn_4 (1.5 ppm) levels compared to control II. Similarly xanthophyll increased by different treatments than control I.

Table (14): **Effect of seed infestation with *F. oxysporum* f.sp. *vasinfectum* and different levels of micro-nutrient elements on disease index and leaf pigments of different cotton varieties Giza 69 and Giza 74 after 45 days from sowing in season 1980.**

Treatment ppm.	Different cotton varieties													
	Giza 69 (Resistant)							Giza 74 (Susceptible)						
	Disease index %	Mg/gm fresh weight						Disease index %	Mg/gm fresh weight					
		Chloropylls			Carotenoids				Chlorophylls			Carotenoids		
		Cloroph-yll a	Chloroph-yll b	Total chlor-ophylls	Carotene	Xantho-phyll	Total Carat-enoids		Chloro-phyll a	Chloro-phyll b	Total chlor-ophylls	Carotene	Xantho phyll	Total Carat-enoids
* Control I	0.00	0.945	0.307	1.252	0.199	0.083	0.282	0.00	0.845	0.280	1.225	0.118	0.061	0.179
** Control II	4.167	0.897	0.272	1.169	0.148	0.114	0.262	12.50	0.571	0.188	0.849	0.176	0.449	0.625
Zn_1 0.75	1.389	1.081	0.338	1.419	0.127	0.195	0.322	4.17	0.744	0.286	1.03	0.153	0.085	0.248
Zn_2 1.50	0.00	0.945	0.280	1.225	0.127	0.149	0.276	12.50	0.981	0.411	1.392	0.116	0.298	0.414
Zn_3 6.0	3.47	0.934	0.263	1.197	0.133	0.149	0.282	15.27	0.864	0.444	1.308	0.136	0.364	0.500
Zn_4 9.00	0.00	0.933	0.292	1.225	0.152	0.173	0.325	17.35	0.782	0.37	1.252	0.165	0.223	0.388
B_1 0.125	5.208	0.969	0.283	1.252	0.160	0.176	0.336	29.16	0.927	0.325	1.252	0.156	0.280	0.436
B_2 0.25	0.00	0.986	0.294	1.25	0.163	0.160	0.323	20.83	0.618	0.189	0.907	0.163	0.127	0.290
B_3 1.00	5.26	0.837	0.248	1.085	0.115	0.143	0.258	20.13	1.314	0.412	1.726	0.083	0.410	0.393
B_4 1.50	5.208	0.949	0.303	1.252	0.142	0.136	0.278	14.58	1.05	0.314	1.364	0.179	0.187	0.366
Cu_1 0.025	4.167	0.837	0.248	1.085	0.141	0.138	0.279	83.30	1.097	0.378	1.475	0.115	0.319	0.434
Cu_2 0.05	2.98	0.912	0.257	1.169	0.137	0.142	0.279	19.44	1.167	0.336	1.503	0.162	0.180	0.342
Cu_3 0.200	5.56	0.877	0.262	1.141	0.113	0.135	0.248	9.72	0.821	0.264	1.085	0.142	0.138	0.280
Cu_4 0.300	4.164	0.871	0.309	1.28	0.105	0.199	0.304	11.11	0.948	0.304	1.252	0.141	0.132	0.273
Mn_1 0.125	5.208	0.933	0.292	1.225	0.150	0.137	0.287	19.231	0.987	0.321	1.308	0.161	0.162	0.323
Mn_2 0.250	0.00	0.897	0.272	1.169	0.125	0.154	0.279	17.56	0.844	0.269	1.113	0.137	0.135	0.272
Mn_3 1.00	0.00	1.038	0.326	1.364	0.174	0.166	0.340	6.41	0.968	0.312	1.28	0.188	0.100	0.288
Mn_4 1.50	16.66	1.117	0.223	1.34	0.126	0.120	0.246	13.89	1.117	0.358	1.475	0.197	0.142	0.339
L.S.D.0.05	1.13	-	-	-	-	-	-	3.05	-	-	-	-	-	-

* Control I = Uninfested seeds grown in normal nutrient solution.

** Control II = Infested seeds grown in normal nutrient solution.

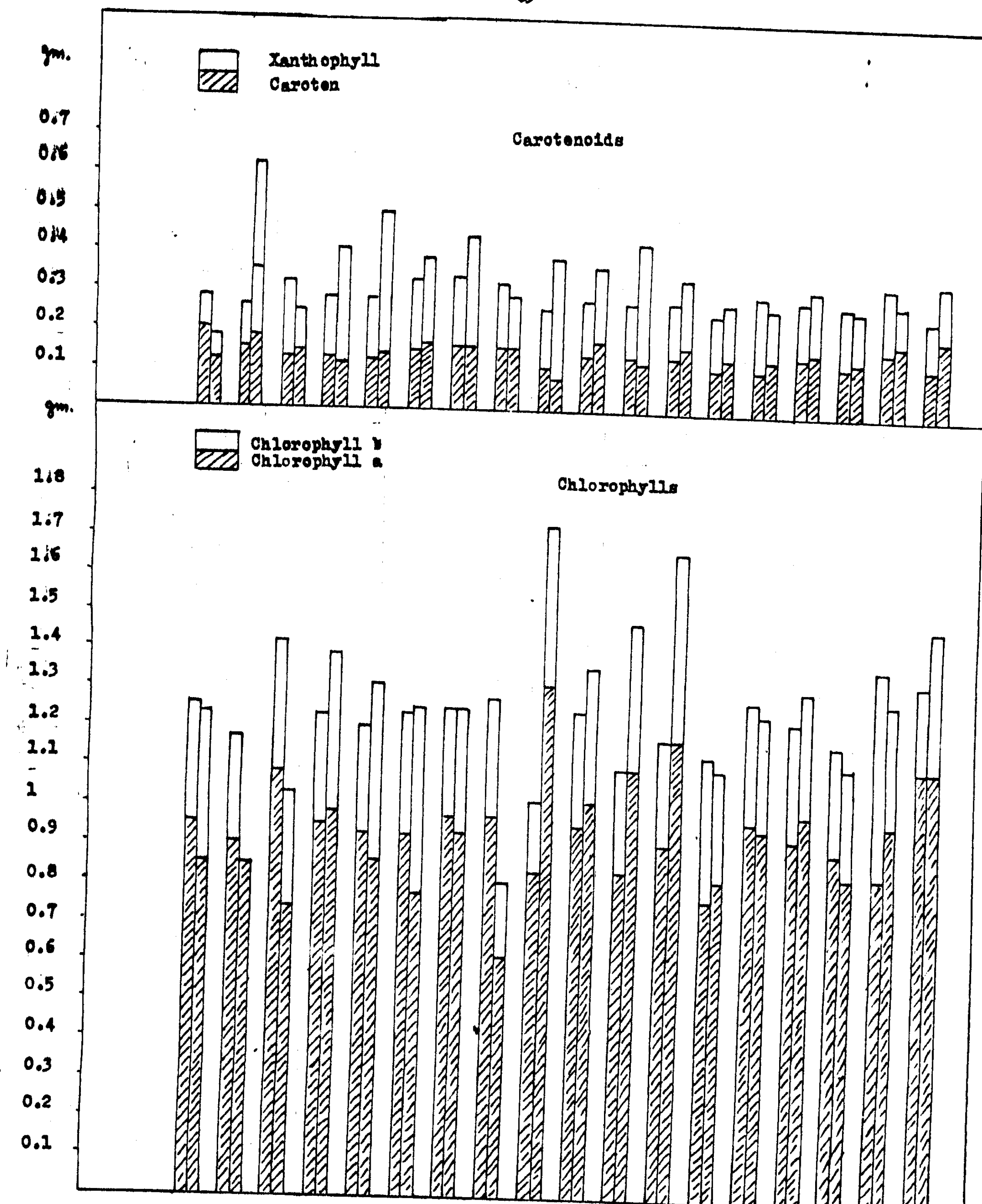


Fig.(8): Effect of seed infestation with *F.oxysporum* f.sp. *vasinfectum* and different levels of micronutrient elements on leaf pigments of different cotton varieties Giza 69 and Giza 74 after 45 days from sowing in season 1980.

Cont.I= Unifested seeds grown in normal nutrient solution.

Cont.II= Infested seeds grown in normal nutrient solution.

IX-Leaf content of macronutrients of some cotton varieties as affected by seed infestation with _F. oxysporum_ f.sp. _vasinfectum_ spores and treated with various levels of macronutrient elements are recorded in Table (15) in season 1979 and Table(16) in season 1980.

Data of Table (15) lead to the following results:-

a) The resistant variety:-

1) The increase in N element increased N % however N_3(200 ppm) increased this percentage to more than control I. Same trend could be noticed as regards the other nutrients (P and Ca). However the highest increase could be noticed in K_2 level (60 ppm).

2) As regards P all the treatments i.e. N,K and Ca reduced its percentage. In this respect control II showed the lowest percentage,compared with control I whereas all treatments showed higher percentages than control II.

3) K percentage was decreased in control II and all other treatments compared with control I except in case of Ca_2(50 ppm).

However, the increase in N and P levels increased its percentage on contrast with K and Ca element in the resistant variety.

4) Ca percentage increased in control II than all other treatments and control I.

b) <u>The susceptible variety:-</u>

1) N percentage increased in control II (infested seeds) and all other treatments than control I (uninfested seeds) except in case of K_3 (240 ppm). The highest percentage was noticed in case of P_3 (64 ppm).

2) P percentage was reduced in control II compared to control I. A high increase was noticed in Ca_2 (50 ppm) and N_2 (200 ppm) levels, whereas P_2 (16 ppm), K_2 (60 ppm) and Ca_3 (200 ppm) show considerable increases than both controls of all treatments except that of Ca_2 (50 ppm) which reduced this percentage slightly. Low values were recorded with K_3, N_3 and P_3.

3) K percentage increased in control II, K_2 (60 ppm) Ca_2 (50 ppm) and Ca_3 (200 ppm) levels whereas slight decreases were noticed in all other treatments.

Table (15) Leaf content of macronutrients of some cotton varieties grown as affected by seed infestation with F.oxysporum f.sp. vasinfectum and treated with various levels of macro-nutrient elements in season 1979.

Treatment ppm.	Different cotton varieties							
	Giza 69 (Resistant)				Giza 74 (Susceptible)			
	N%	P%	K%	Ca%	N%	P%	K%	Ca%
* Control I	3.206	0.680	2.55	1.25	2.716	0.199	1.60	3.50
** Control II	2.870	0.079	1.50	3.75	3.584	0.163	2.50	2.00
N_2 50	2.89	0.253	1.80	2.50	3.598	0.653	1.80	2.25
N_3 200	4.116	0.213	2.50	1.00	3.430	0.133	2.35	3.50
P_2 16	3.444	0.520	1.90	2.75	2.842	0.213	2.10	2.50
P_3 64	3.850	0.546	2.10	1.75	3.822	0.146	2.10	2.75
K_2 60	4.487	0.286	2.40	1.25	3.276	0.233	3.40	2.00
K_3 240	3.871	0.186	2.30	1.75	2.464	0.133	2.25	1.75
Ca_2 50	3.185	0.679	3.25	1.25	3.556	0.680	3.15	1.00
Ca_3 200	3.710	0.139	2.25	2.50	3.528	0.219	3.00	2.50

* Control I = Uninfested seeds grown in normal nutrient solution.

** Control II = Infested seeds grown in normal nutrient solution.

4) Ca percentage was reduced in control II and all the other treatments compared to controll I except in case of N_3 level (200 pmm). However, the lowest percentage was noticed in Ca_2 level (50 ppm).

Data in Table (16) and Fig (9) lead to the following results:

a) <u>The resistant variety:</u>

1) It is clear that increasing the level of N and Ca elements increased N percentages in the leaves compared to control II except Ca_4(300 ppm), while flactuation was noticed with P and K. The highest percentage of N was noticed with the highest levels of N element N_3(200 ppm) and N_4 (300 ppm).

As regards P % general decrease nearly could be noticed in all treatments especially P_1 (8 ppm) and Ca_1 (25 ppm). compared with control I. However the highest percentage was noticed with the highest level of P element (P_4 96 ppm).

As for K % general increase than control I was noticed and the highest percentage was with level P_4(96 ppm) and K_4(360 ppm) however, the lowest one was with N_4 level (300 ppm).

Also as regads Ca % it was reduced in control II compared to control I. However, most treatments increased it than control II except at P_1 (8 ppm), K_3 (240 ppm) and Ca_1 (25 ppm) levels. However the highest percentage was obtained with N_3 (200 ppm), P_4 (100 ppm) Ca_3 and Ca_4 (300) levels.

b) <u>The susceptible variety:-</u>

1) Similar trend as regards N % was noticed as in the resistant variety.

The other treatments increased N % than control II.

2) General decrease in P % was noticed with all treatments compared to control I. except in case of K_2 (60 ppm) which gave the highest percentage of all treatments.

3) The percentages of K were nearly similar to the controls I and II. However the highest percentage was obtained at P_4 level (100 ppm).

4) General increase than control II was noticed in the percentage of Ca and the highest percentage was obtained at K_2 level (60 ppm).

Table (16) Leaf content of macro-nutrients of some cotton varieties grown as affected by seed infestation with F.oxysporum sf.sp. vasinfectum and treated with various levels of macro-nutrient elements in season 1980.

Treatment ppm.	Different cotton varieties							
	Gisa 69(Resistant)				Giza 74(Susceptible)			
	N%	P%	K%	Ca%	N%	P%	K%	Ca%
* Control I	4.97	0.272	1.88	3.5	4.34	0.154	2.46	2.125
** Control II	4.886	0.112	2.12	2.125	3.71	0.069	2.32	1.00
N_1 25	3.528	0.136	2.28	2.625	3.36	0.093	2.08	1.375
N_2 50	4.802	0.087	1.82	2.875	4.27	0.091	2.46	1.25
N_3 200	6.356	0.180	1.74	3.125	5.74	0.080	2.34	1.625
N_4 300	6.468	0.117	1.56	2.500	6.16	0.097	2.16	2.125
P_1 8	4.396	0.082	1.80	0.875	4.06	0.082	2.44	1.125
P_2 16	3.850	0.112	1.92	2.75	3.99	0.074	2.32	1.25
P_3 64	5.46	0.227	2.76	1.625	4.48	0.143	2.74	1.25
P_4 100	4.69	0.374	3.20	3.625	4.34	0.143	3.16	1.50
K_1 30	5.04	0.120	2.44	2.125	3.85	0.104	2.10	1.375
K_2 60	4.41	0.197	2.52	1.875	4.34	0.247	2.08	2.25
K_3 240	4.90	0.186	2.72	1.00	4.48	0.080	2.36	1.25
K_4 360	4.34	0.164	3.10	1.625	3.71	0.039	2.52	0.875
Ca_1 25	1.82	0.099	2.16	0.875	4.62	0.095	2.72	1.00
Ca_2 50	5.32	0.100	1.92	1.500	4.34	0.108	2.56	2.00
Ca_3 200	5.39	0.132	1.80	3.000	4.13	0.106	2.34	1.75
Ca_4 300	4.20	0.084	1.80	3.125	3.85	0.076	2.16	2.00
L.S.D 0.05	0.58	0.115	0.331	0.733	0.653	0.106	0.442	0.562

* Control I = Uninfested seeds grown in normal nutrient solution.

** Control II = Infested seeds grown in normal nutrient solution.

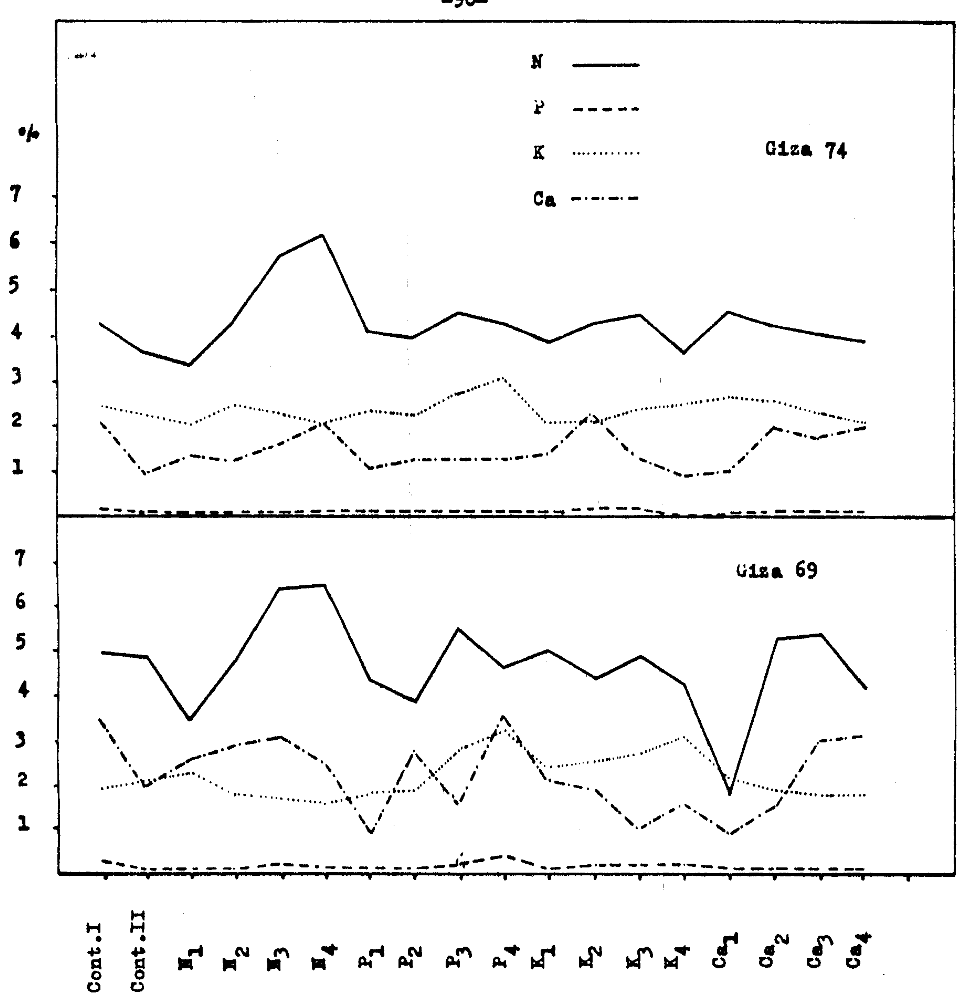


Fig.(9) Leaf content of macro-nutrients of some cotton varieties grown as affected by seed infestation with F. oxysporum of sp. vasinfectum and treated with various levels of macro-nutrient elements in season 1980.

X- Leaf contents of macronutrients of some cotton varieties as affected by seed infestation with *F. oxysporum* f.sp. *vasinfectum* spores and treated with various levels of micronutrient elements were recorded in Table (17) in season 1979 and Table (18) in season 1980.

Data of Table (17) lead to the following results:-

a) The Resistant variety:-

1) Seed infestation (control II) decreased N %. The increase in Zn and B levels increased this percentage on contrast with Cu. However, the highest percentage were noticed at the highest levels of the first two micro-elements (Zn_3 (6 ppm) and B_3 (1 ppm) and the lowest one of the third one (Cu_3 0.2 ppm).

2) Seed infestation (control II) decreased greathy P%. Agreat increase than control II however not increasing than control I was noticed in all treatments especially Zn_2 (1.5 ppm) and Zn_3 (6 ppm). The least percentage was noticed in B_3 (1 ppm) followed by control II.

3) Similar trend of results as P % was noticed in case of K % however, the least percentages were noticed in Cu_2 (0.22 ppm) and Cu_3 (0.2 ppm) levels.

4) As regards Ca % it increased greatly by seed infestation (Control II) but general decrease than control II however, more than control I is noticed in all treatments except Cu_2 level (0.05 ppm).

b) <u>The susceptible variety:-</u>

1) The percenlage of N increased generally in control II and all other treatments.

2) Great increases in P % is noticed in all the treatments except control II and Zn_2 level (1.5 ppm). The highest percentage was obtained with B_3 level (1 ppm) followed by Cu levels.

3) General increase in K % was noticed in all treatments. The highest percentage was obtained at Cu_2 level (0.05 ppm). However, this percentage increases with the increase in Zn and B levels on contrast with Cu levels.

Table (17) Leaf content of macro-nutrients of some cotton varieties grown as affected by seed infestation with *Fusarium oxysporum* f.sp. *vasinfectum* and treated with various levels of macro-nutrient elements in season 1979.

Treatment ppm.	Different cotton varieties							
	Giza 69 (Resistant)				Giza 74 (Susceptible)			
	N%	P%	K%	Ca%	N%	P%	K%	Ca%
* Control I	3.206	0.680	2.55	1.29	2.716	0.199	1.6	3.5
** Control II	2.870	0.079	1.50	3.75	3.584	0.163	2.5	2.00
Zn_2 1.5	3.094	0.526	2.10	2.50	3.248	0.179	1.90	1.50
Zn_3 6.0	3.626	0.666	1.90	1.75	3.836	0.300	2.25	1.25
B_2 0.25	2.870	0.500	2.05	1.75	3.406	0.426	2.40	3.00
B_3 1.0	3.570	0.259	2.05	1.75	3.262	0.719	2.50	1.25
Cu_2 0.05	3.472	0.473	1.55	1.00	3.318	0.593	2.65	3.50
Cu_3 0.20	2.604	0.446	1.70	1.50	3.304	0.580	2.25	1.25

* Control I = Uninfested seeds grown in normal nutrient solution

** Control II = Infested seeds grown in normal nutrient solution.

4) General decrease in the percentage of Ca % than control II was noticed in all treatments except B_2 (0.25 ppm) and Cu_2 (0.05) ppm) levels. However, the increase in all the tested micro-elements decreased this percentage.

Table (18) and Fig. (10) lead to the following results:-

a) <u>The resistant variety:-</u>

1) As regards N % little differences could be noticed between different treatments. However the increase in Zn and Mn levels reduced this percentage on contrast with B level. The highest percentage was noticed at Mn_2 level (0.25 ppm).

2) General increase than control II could be noticed in all treatments as regards P %. The highest percentage was noticed in Zn_3 (6 ppm) and the lowest one was in Zn_2 (1.5 ppm).

3) General increase than control II could be noticed in all treatments as regards K %. The highest percentage was obtained at Mn_1 (0.125 ppm) and Zn_4

(9 ppm) levels. The increase in Zn and B levels inc-reases K % on contrast with Cu and Mn levels.

4) General decrease is noticed in all treatment and control II in Ca %. The increase in B increases Ca % especially at B_3 (1 ppm). The reverse is noticed in other microelements.

b) <u>The susceptible variety:-</u>

1) General increase than control II (infested seeds) in N % was noticed in all treatments. The highest percentage was noticed at Cu_1 (0.025 ppm) while the lowest one was at Zn_1 level (0.75 ppm).

2) As regards P % general decrease is noticed in control II and different treatments except in case of Zn_1 level (0.75 ppm) only.

3) No significant differences could be noticed in all treatments as regards K %. The highest percentage was noticed at B_1 (0.125 ppm), B_2 (0.25 ppm) and Mn_1 (0.125 ppm) levels.

4) As regards Ca % it was decreased in control II and all other treatments increases than control II esp-ecially Zn_2 (1.5 ppm), Zn_3 (6 ppm), B_1 (0.125 ppm) and Zn_4 (1.5 ppm) levels, whereas the lowest percen-tages were noticed at Mn_3 level (1 ppm) and control II.

Table (18) Leaf content of macro-nutrient of some cotton varieties grown as affected by seed infestation with F. oxysporum f.sp. vasinfectum and treated with various levels of macro-nutrient elements in season 1980.

Treatment ppm.	Different cotton varieties							
	Giza 69 (Resistant)				Giza 74 (Susceptible)			
	N%	P%	K%	Ca%	N%	P%	K%	Ca%
* Control I	4.97	0.272	1.88	3.5	4.34	0.154	2.46	2.125
** Control II	4.886	0.112	2.12	2.125	3.71	0.069	2.32	1.00
Zn_1 0.75	5.04	0.125	2.24	2.875	3.15	0.212	2.46	1.875
Zn_2 1.5	4.83	0.113	2.44	2.875	4.55	0.091	2.44	3.375
Zn_3 6.00	4.97	0.273	2.46	2.00	4.27	0.052	2.16	3.500
Zn_4 9.00	4.97	0.136	2.72	2.00	4.62	0.089	2.44	3.125
B_1 0.125	3.78	0.126	2.36	1.75	4.62	0.052	2.63	3.25
B_2 0.250	5.25	0.121	2.36	2.00	4.62	0.078	2.68	1.875
B_3 1.00	5.25	0.126	2.60	2.375	4.48	0.084	2.24	2.25
B_4 1.5	5.04	0.126	2.60	1.875	4.62	0.071	2.28	3.00
Cu_1 0.025	4.62	0.143	2.40	2.625	5.74	0.074	2.50	1.50
Cu_2 0.05	4.62	0.160	2.54	1.625	4.83	0.084	2.54	1.75
Cu_3 0.20	4.97	0.120	2.44	1.50	5.32	0.045	2.44	3.50
Cu_4 0.30	4.48	0.126	2.42	2.25	4.27	0.086	2.44	1.75
Mn_1 0.125	5.32	0.145	2.96	1.625	4.2	0.058	2.60	1.25
Mn_2 0.250	5.53	0.145	2.52	1.125	3.57	0.095	2.42	1.125
Mn_3 1.00	5.18	0.121	2.48	0.875	4.13	0.073	2.48	1.00
Mn_4 1.5	4.90	0.125	2.48	1.50	3.78	0.067	2.48	1.50
L.S.D.0.05	N.S	N.S	0.294	0.500	0.79	0.045	N.S	0.527

* Control I = Uninfested seeds grown in normal nutrient solution.
** Control II = Infested seeds grown in normal nutrient solution.

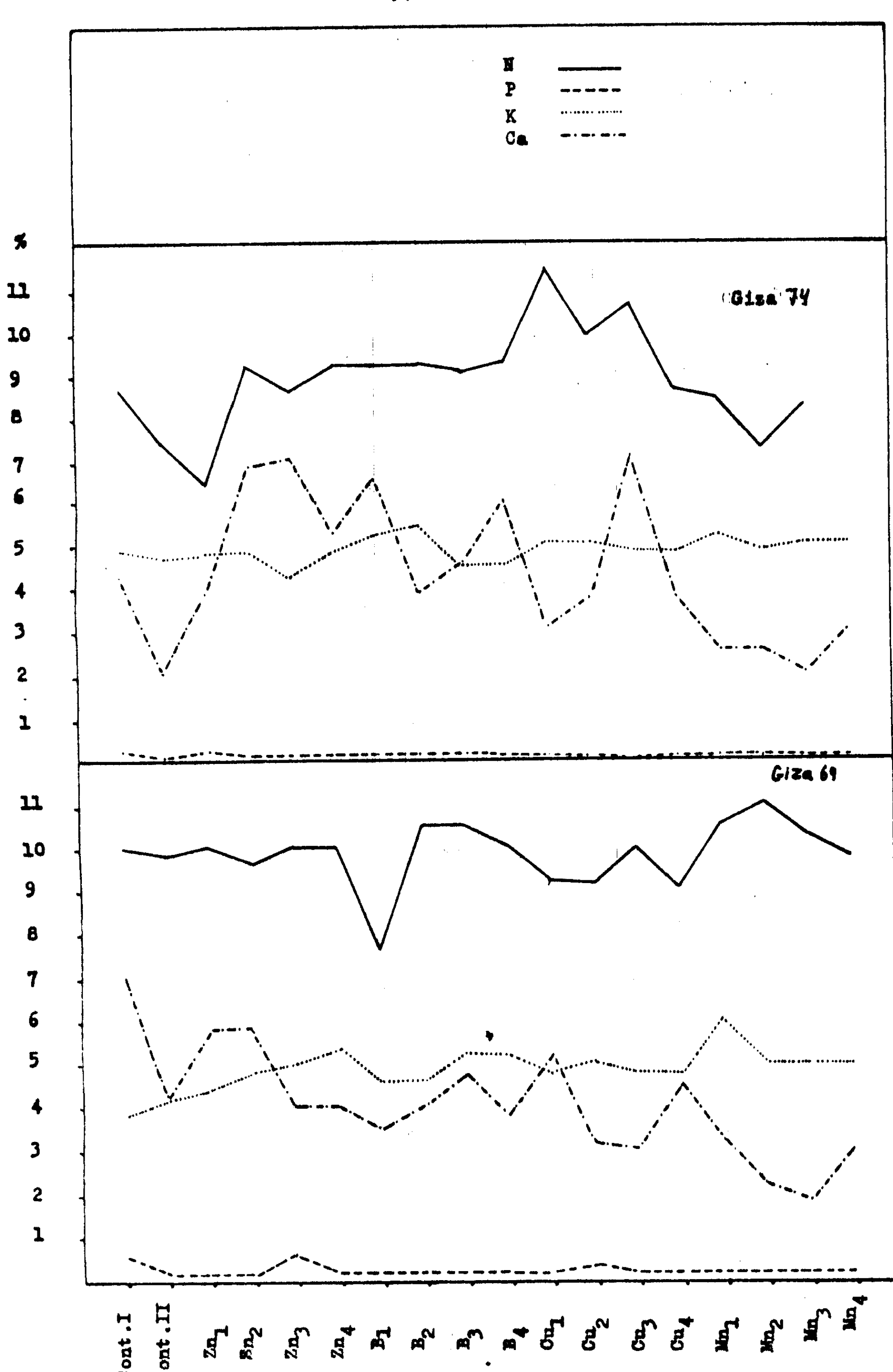


Fig.(18): Leaf content of macro-nutrients of some cotton varieties grown as affected by seed infestation with F. oxysporum of sp. varinfectum and treated with various levels of micro-nutrient elements in season 1980.

XI- Leaf content of micronutrients of some cotton varieties as affected by seed infestation with _F. oxysporum_ f.sp. _vasinfectum_ spores and treated with various levels of macronutrient elements are recorded in Table(19) in season 1980.

Data of Table (19) and Fig.(11) lead to the following results:

a) The resistant variety:

1) Seed infestation with _F . oxysporum_ f.sp._vasinfectum_ spores increased leaf contents of Fe and the reverse could be noticed in case of Zn. As regards Mn and Cu no differences could be noticed in their contents.

2) The increase in N level nearly decreased Fe content of the leaves on contrast with the other macroelements P, K and Ca. The highest content is noticed at Ca_1 level (25 ppm) and the lowest one is noticed at K_2 level(60 ppm).

3) The increase in N level decreased Zn content especially N_3 level (200 ppm) compared to control II. As regards P level its increase increased Zn content and the lowest content could be noticed in this respect as regards the different K levels. Ca nearly show similar trend as P element.

4) The increase in N, P, K and Ca levels almost increased Mn content, however the highest content was noticed at N_4 level (300 ppm) and the lowest was at N_2 (50 ppm). and K_2(60 ppm) levels.

5) No differences were noticed in Cu contents by increasing N,K and Ca levels, however the increase in P decreased Cu content. The highest levels were noticed in N_1(25 ppm), N_3 (200 ppm), N_4(300 ppm) P_2(16 ppm) and P_1 (8 ppm).

b) The susceptible variety:

1) Seed infestation (control II) increased Fe content and decreased that of Zn and Cu whereas that of Mn was not altered.

2) The increase in N levels increased Fe content till N_3(200 ppm), then a sharp reduction could be noticed, Similar trend was noticed as regards Zn and Mn elements.

As for Cu its contents increased at N_2 (50 ppm) and N_4 (300 ppm) levels.

3) P-element shows reverse trend to that of N as regards Fe to reach it's minimum at P_3 level 64 ppm) then increases again. As regards it's effect on Zn and Cu contents it is in the same trend which reach's the minimum at the third level, then increases again.

As for Mn it's content increased at P_1 (8 ppm) and P_3 (64 ppm) levels and is similar to that of control II at P_2 (16 ppm) and P_4 (100ppm).

4) K-element increases Zn content at K_1 (30 ppm) than control II then decreases sharply at K_2 level (60 ppm) then increases again, However, K-element did not affect Mn content at all levels. While Cu content was Zero ppm at K_1 (30 ppm) and K_4 (360ppm) levels and was similar as control I in levels K_2 (60 ppm) and K_3 (240 ppm).

5) As regards Cu effect on Zn a reduction was noticed by increasing it's levels and the reverse was noticed with Mn and Cu contents.

Table (19) Leaf content of micro-nutrients of some cotton varieties grown as affected by seed infestation with F.oxysporum f.sp.vasinfectum and treated with various levels of macro-nutrient elements is season 1980.

Treatment ppm.	Leaf content ppm.							
	Giza 69 (Resistant)				Giza 74 (Susceptible)			
	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu
* Control I	160	120	75	40	140	80	75	20
** Control II	200	80	75	40	160	30	75	10
N_1 25	180	140	100	40	160	80	75	10
N_2 50	120	110	50	30	160	110	75	20
N_3 200	180	30	150	40	180	100	150	10
N_4 300	60	100	175	40	60	70	200	20
P_1 8	160	50	100	40	250	110	100	20
P_2 16	160	100	75	40	160	20	75	10
P_3 64	120	110	75	25	120	50	100	00
P_4 100	120	80	100	20	180	100	75	20
K_1 30	180	50	75	20	200	80	75	00
K_2 60	30	50	50	20	250	20	75	20
K_3 240	160	50	75	20	300	100	75	20
K_4 360	140	50	75	20	140	70	75	00
Ca_1 25	450	100	75	20	60	50	100	30
Ca_2 50	100	80	100	20	250	20	100	30
Ca_3 200	200	150	75	20	180	20	75	20
Ca_4 300	350	100	100	20	180	20	100	20

* Control I = Uninfested seeds grown in normal nutrient solution.

** Control II = Infested seeds grown in normal nutrient solution.

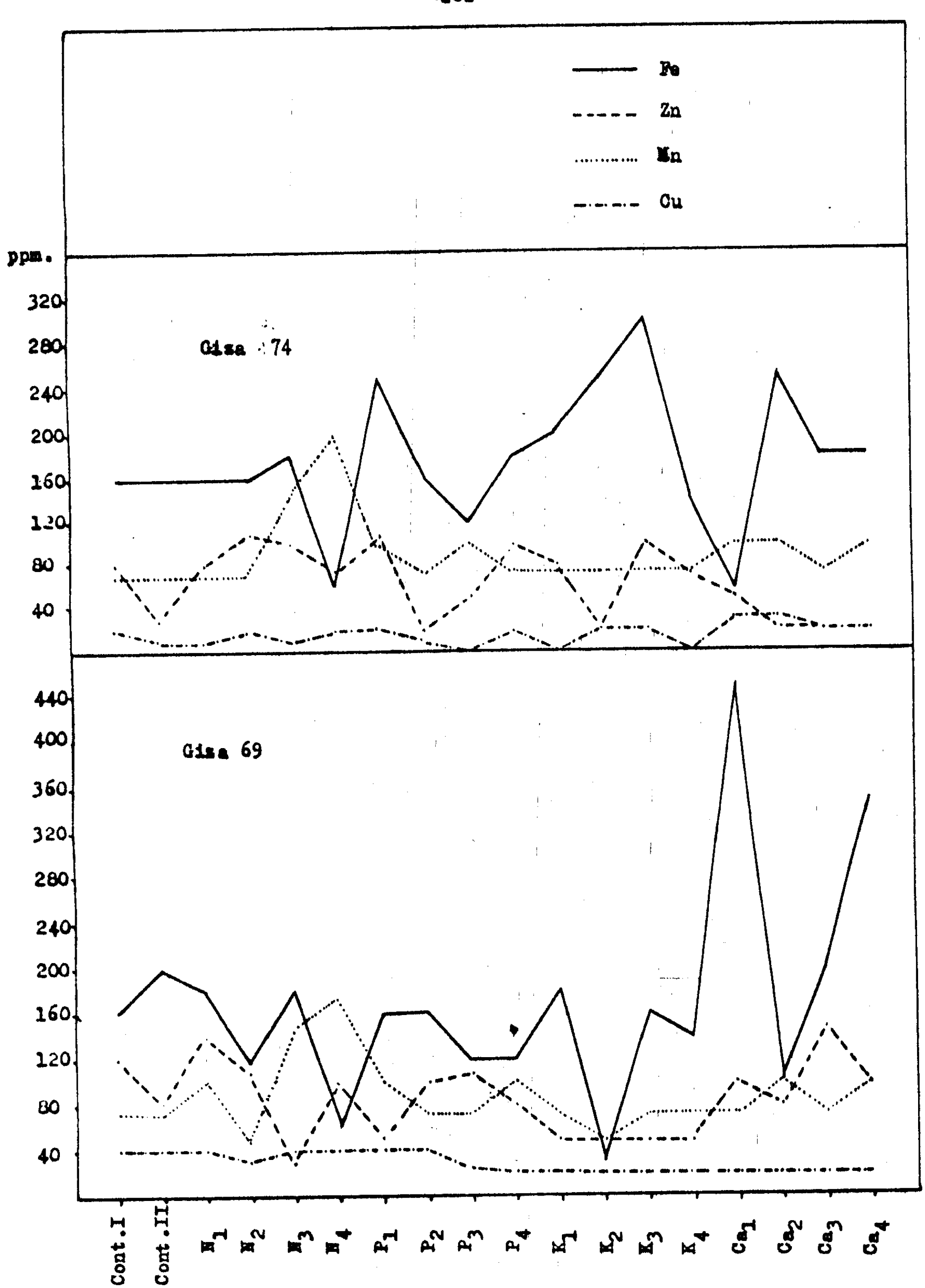


Fig.(11): Leaf contents of micro-nutrients of some cotton varieties grown as affected by seed infestation with F.oxysporum of sp. varinfectum and treated with various levels of macro-nutrient elements in season 1980.

Cont.I = Uninfested seeds grown in normal nutrient solution.
Cont.II = Infested seeds grown in normal nutrient solution.

XII- Leaf content of micronutrients of some cotton varieties as affected by seed infestation with *F. oxysporum* f.sp *vasinfectum* spores and treated with various levels of micronutrient elements were recorded in Table (20) in season (1980).

Data in Table (20 and Fig.(12) lead to the following results:-

a) The resistant variety:-

1) Seed infestation increased Fe and decreased Zn contents and did not affect Mn or Cu contents.

2) Zn_1 level (0.75 ppm) increased Fe content and the increase in its level decreases it considerably. Similar trend could be noticed as regards Cu and Mn levels. However, B levels decreased it's content than control I and II except in case of B_4 level (1.5 ppm). The highest content was obtained at Cu_1 level (0.025 ppm).

3) The increase in Zn decreased Zn contents except in case of Zn_4 (9 ppm). Same trend was noticed as regards Cu levels. However, the highest concentration was noticed in case of Zn_2 (1.5 ppm) followed by Cu_4 (0.3 ppm) and the lowest concentration was at Zn_4 level (9 ppm).

4) Little differences in Mn content as affected by different treatments were noticed except in case of Zn_4(9 ppm), B_1(0.125 ppm), B_2 (0.25 ppm), B_3(1 ppm), Cu_1 (0.025 ppm) and Mn_1 (0.125 ppm) which increased these contents considdrably. In this respect, the lowest content was noticed in case of Cu_3 level(0.2 ppm).

5) Similar trend in case of Cu content as in Mn was noticed and the lowest contents were obtained in case of B_4 level(1.5 ppm).

b) The susceptible variety:

1) Seed infestation increased Fe content and decreased Zn and Cu contents and did not affect Mn.

2) As regards Fe contents it is clear that Zn and Mn decreased its contents then increases again at the fourth level. The reverse almost was noticed as regards B and Cu levels.

3) Zn content increased by all treatments except Zn_2, B_2 and Cu_1 compared with control II.

As regards Cu effect, a great reduction is noticed at Cu_1 (0.025 ppm) and Cu_3 (0.2 ppm) levels then increases greatly at Cu_2 (0.05 ppm) and Cu_4 (0.3 ppm) levels.

4) As regards Mn content, little differences could be noticed between all treatments. However, it increases at Zn_3 (6 ppm), B_4 (1.5 ppm) and Cu_3 (0.2 ppm) levels to reach it's maximum and the lowest contents were noticed at Mn_2 (0.25 ppm) and Mn_3 (1 ppm) levels.

5) General decrease in Cu content in all treatments could be noticed. It reaches Zero ppm at Zn_4 (9 ppm), B(0.125 ppm), Cu_2 (0.025 ppm), Cu_3(0.2 ppm), Mn_1(0.125 ppm) and Mn_3 (1 ppm) levels and reaches it's maximum at B_3 (1 ppm) and B_2 (0.25 ppm) levels.

Table (20) Leaf content of micro nutrients elements of some cotton varieties grown as affected by seed infestation with F. oxysporum f.sp. vasinfectum and treated with various levels of macro nutrient elements in season 1980.

Treatment ppm.	Leaf content ppm.							
	Gisa 69 (Resistant)				Gisa 74 (Susceptible)			
	Fe	Zn	Mn	Cu	Fe	Zn	Mn	Cu
* Control I	160	120	75	40	140	80	75	20
** Control II	200	80	75	40	160	30	75	10
Zn_1 0.75	350	110	75	20	250	80	75	10
Zn_2 1.5	310	200	75	40	120	20	75	10
Zn_3 6.00	200	80	75	20	120	50	100	10
Zn_4 9.0	120	30	100	40	250	100	75	0
B_1 0.125	140	110	100	20	180	50	75	0
B_2 0.250	140	80	100	20	200	20	75	10
B_3 1.00	400	50	100	20	180	100	75	40
B_4 1.5	140	80	50	10	430	80	100	40
Cu_1 0.025	430	110	100	20	120	20	75	10
Cu_2 0.05	120	140	75	40	300	100	75	0
Cu_3 0.200	180	110	25	20	180	30	100	0
Cu_4 0.300	120	160	75	20	180	100	75	10
Mn_1 0.125	350	50	100	30	250	80	75	0
Mn_2 0.25	120	80	75	20	200	100	50	0
Mn_3 1.00	180	80	75	40	120	80	50	0
Mn_4 1.50	160	50	75	40	180	100	75	10

* Control I = Uninfested seeds grown in normal nutrient solution.

** Control II = Infested seeds grown in normal nutrient solution.

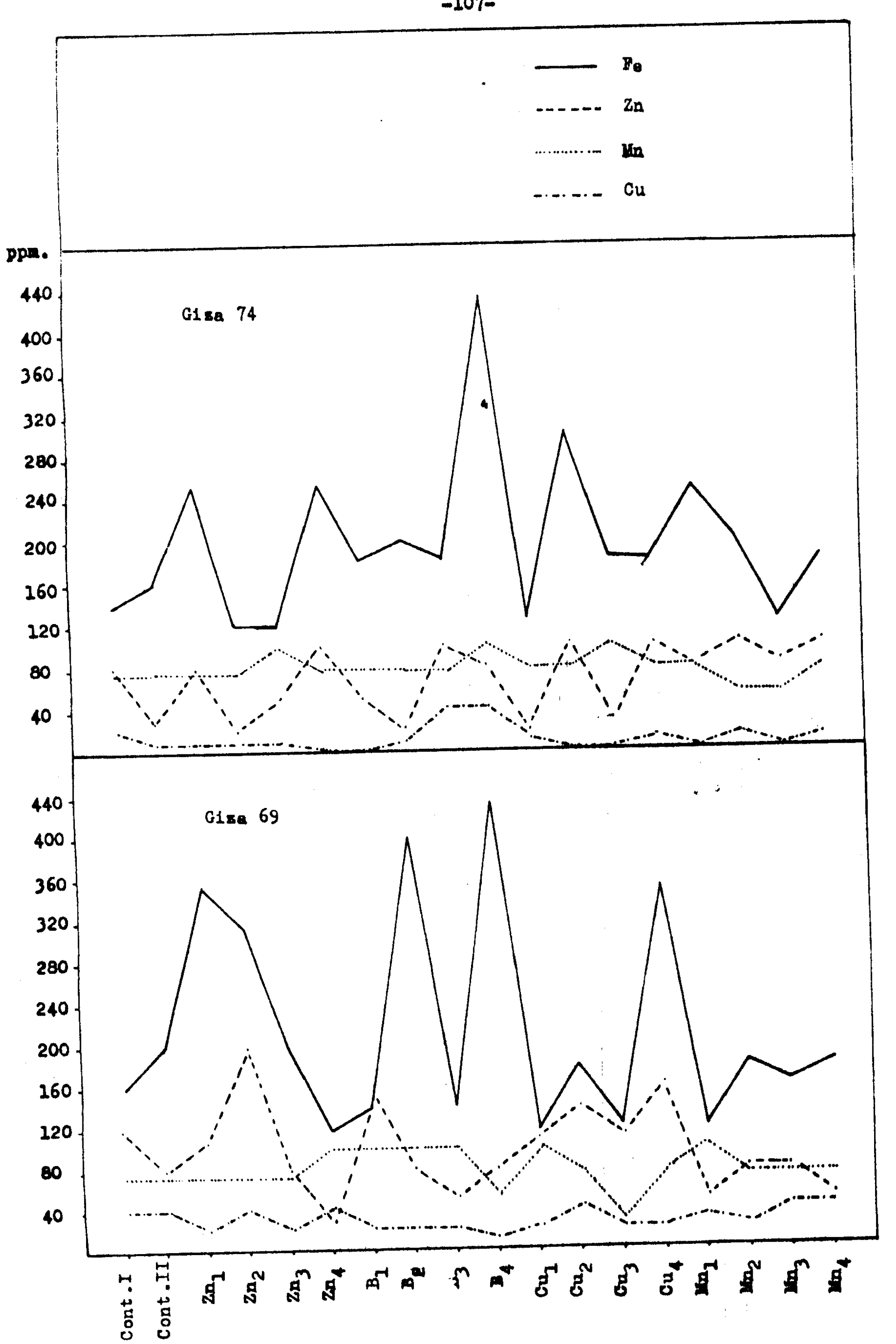


Fig.(12): Leaf contents of micro-nutrients of some cotton varieties grown as affected by seed infestation with F.oxysporum of sp. varinfectum and treated with various levels of macro-nutrient elements in season 1980.

Cont. I = Uninfested seeds grown in normal nutrient solution.
Cont. II = Infested seeds grown in normal nutrient solution.

DISCUSSION

The percentage of germination and healthy survival seedlings were decreased markedly by seed infestation with spores of *Fusarium oxysporum* f.sp. *vasinfectum* in both tested cotton varieties particularly Giza 74 (susceptible) in the two seasons. This could be attributed to the presence of phytotoxic substances secreted by or dissolved from the spores especially fusaric acid. This might confirm Gaumann (1957). Reduction of germination by *Fusarium* infestation was reported by Roncadori *et al* (1971). Gubanov and Sabirov (1972) were able to show the penetration of seed coat by the spores that spread into xylem. The more germination reduction by susceptible than by resistant variety could be due to the more sensitivity to these substances produced by the spores.

Fairly high level of N,P,K and Ca application improved the percent of germination and healthy survival seedlings more in resistant than suseptible variety. Chi and Hanson(1962) reported that least plant growth and most disease developed was at the lowest concentration of each nutrient of N,P or K. From the

preceeding results it could be concluded that the physiological resistance induced by these nutrients seemed to be higher in Giza 69 than Giza 74 variety. Zn; Cu and Mn increased the percent of survival plants in both varieties and Giza 69 (resistant variety) in particular. This is in agreement with Fahim et al. (1971) who reported that presoaking of Karnak-cotton seeds for different periods in a solution containing any of the microelements Boron, Zinc, Copper, Manganese or Molybdenum decreased wilt incidence. In addition this incidence decreased with increase of microelement concentration or increasing persoaking periods.They also added that Zinc and Boron proved to be the most efficient in reducing disease severity. However, the percentages of germination and survivals were fluctuated with levels of the used microelement, but generally the moderate levels of Zn, Cu and Mn improved the forementioned criteria, while high B was needed to do the same in Giza 69 (resistant variety). This could be attributed to the fact that these micronutrients are very effective on plant growth as trace elements at relatively low levels but when high concentrations are available they begin to be phytotoxic to both the host and parasite.Thus moderate levels could

enhance plant growth and in the same time inhibit the parasite.

High K decreased disease index in both varieties especially the susceptible one. The role played by K-element is well noticed and recorded by many investigators. Among them, Miles (1936) who reported that, the decrease of cotton wilt by the application of high K. Sharoubeem *et al*. (1966a) who reported that K deficiency did not affect the resistance of Ashmouni variety to *Fusarium* wilt but it did in the susceptible Karnak variety.

Generally, it seems that high N increases disease index in both varieties while P,K and Ca decrease it. It is well known that high N renders the plant tissues more suceulent, with thin walls which enables the invading fungus to penetrate and grow easily and consequently increase the infection.The increase of wilt susceptibilly by high N was reported by Ashour *et al*. (1964). Same results were reported by El-Nur and Fattah (1970).

The suppression of disease index by the micronutrients used was higher in resistant variety than in susceptible one. Moreover, the micronutrients improved

growth of the resistant variety. This could be attributed either to sensitivity of the susceptible variety and or/the ability of the resistant one to grow vigorously and consequently escape the disease or resist the infection. Regardless of the fluctuation observed in the second season, Mn and the other micronutrients seemed to improve the resistance to the disease and hence improve the growth of plant. These results would support many investigators (Sulochana (1952a), (1952b), Sadasivan and Subramanian (1954) and Stepantsev (1957).

Reduction of total amino acids was marked in the susceptible variety compared with the resistant one. This could be attributed to fungal consumption of these amino acids as it grows vigorously in the susceptible plants than resistant one.

P,K and Ca seemed to increase the levels of amino acids in both varieties especially in the susceptible one.

P and Ca slightly increased sugar contents in both varieties. This might be attributed to the role of these nutrients of carbohydrate metabolism.

Zn and B increased sugar and all micronutrients increased total amino acids in Giza 79. This is in agreement with Alieva (1962) who reported that Cu and Mn had the greatest influence on carbohydrate metabolism and increased the carbohydrate content of leaves.Also Tagi-Zade (1954) reported that when B, Zn and Cu were applied at different stages of growth, they increased the intensity of carbohydrate synthesis in leaves.

Total phenols were higher in infested plants than free ones. This may be in agreement with some investigators (Kati Reddy and Mahadevan (1967)).

Generally, the disease index was much higher in Giza 74 than Giza 69. Both chlorophylls and carotenoids were reduced by seed infestation in Giza 74 much more than Giza 69. This is in agreement with Kreshnamani and Lakshananan (1976) who recorded that both resistant and susceptible cotton cvs. showed reduced rate of photosynthesis when infected with F.oxysporum f.sp. vasinfectum. This also in agreement with Abou-Zaid (1977) who concluded that the pigment reduction in susceptible Giza 74 was more than Giza 69.

Macronutrients increased total chlorophyll and total carotenoids in both varieties especially in the susceptible one (Giza 74). They also generally suppressed the infection.

Despite the differences in the results between the two season, plant contents of chlorophylls and carotenoids, seemed to increase by macronutrient application in both varieties. This may be due either to the role played by these macronutrients in stimulating chlorphyll synthesis or their suppressive effect on the disease. Results indicated the good influence of the nutrients when applied at high levels except nitrogen in increasing plant growth in general. This is in agreement with Zununov and Lipkind (1969) who reported that application of P slightly increased the green pigment content.

High levels of the micronutrients used suppressed the disease in both varieties; This could be attributed to their fungistatic effect on the fungus at these high concentration. They also had their improvement on both chlorophylls and carotenoids in both varieties. This might indicate the participation of these micronutrients in chlorophyll synthesis.

P was much reduced in leaves of Giza 69 variety. Reduction of P absorption in the same plants was reported by Haag _et al_.(1971).

N increased by increasing its concentration in the nutrient solution in the same resistant variety. This clearly shows that, the increase in N levels enhances N absorption. It also indicates that excess of this nutrient leads to the deficiency in other nutrients(P & K) and thus the susceptibility of the plant to disease increases as was found here. Similar results were reported by Young and Tharp (1941).

Generally, N and P increased proportionally with their increase in the nutrient solution in both varieties. However, P increase in the nutrient solution markedly encouraged N absorption in the susceptible variety. This might indicate that N is more important than P in N-P relation in plants.

Zn and B increased N and P content of the leaves of Giza 69 while B and Cu increased them in Giza 74. P and K were reduced markedly by infection in Giza 74. Reduction of P absorption by infection was reported earlier by Haag et al(1971).

High Zn stimulated the absorption of P in Giza 69 and Ca in Giza 74 and either high or low Cu or moderate B stimulated Ca absorption in the resistant variety. High or low Mn stimulated Ca absorption in Giza 69. Generally, infection reduced P and Ca in both varieties. These results are in conformance with Sharoubeem et al. (1966 b).

High P seemed to reduce Fe, Zn and Cu in Giza 69. While high K decreased absorption of Cu and Zn in Giza 69. This is in agreement with Fakhrudinov (1975) who mentioned that application of high P rates decreased the plant Zn contents. Applied K normalized the Zn and P uptake by plants.

Law Ca seemed to encourage Fe, Zn and Mn absorption in Giza 69 variety.

High Mn reduced the absorption of Fe from the nutrient solution in both varieties. This is in conformance

with Pearse (1944) who showed that Mn oxidizes iron in culture solution to the ferric state decreasing its uptake.

Infestation increased Fe and decreased Zn in both varieties, Zn seemed to encourage its uptake by Giza 74 variety.Soaking cotton seeds in Zn solution immproved the growth as was found by Singh (1961). However, addition of Zn to reduce infection might be indicated.

Further work on the effect of these micronutrient is needed to supstanciate the preceeding results and discussion, as the literature is almost devoid of subject.

SUMMARY

In potted pure sand culture, two varieties (Giza 69, as resistant one and Giza 74 as suceptible to the *Fusarium* disease) of Egyptian cotton plants were grown in two successive season (1979 and 1980) in the green house. Both seeds and sands were infested by the spores of the *Fusarium* fungus (*Fusarium oxysporum* f.sp *vasinfectum*) before sowing and the resulting seedlings were treated by various levels of each of the different nutrient elements in addition to the complete nutrient solution as a control. All these treatments were compared with infested-free control recieving the same complete nutrient solution.

All criteria of germination, post-emergence damping-off, survival seedlings, disease index, growth (hieghts and dry weights of both root and tops) and the foliar chemical contents (sugars, total amino acids, phenolic compounds, pigments (chlorophylls and carotenoids) and the nutrient elements concentration in the leaves were all determined and tabulated.

The average results of the two seasons were varied considerably according to the type of treatments.

1) Infestation:-

It inhibited germination particularly of the susceptible variety.

Post-emergence damping-off was also generally increased while seedling survivals decreased.

Disease index increased while growth generally decreased in susceptible one as well as the total amino acids, in addition it increased phenols(in Giza 74).

The decrease in the pigments in the susceptible one (Giza 74) was more than in the resistant one (Giza 69).

It seems that infestation inhibited the uptake of P and K more in Giza 74 than in Giza 69 varieties.

The decrease in foliar content of Zn and Cu in Giza 74 variety was also noticed.

2- Nitrogen (N):

It increased germination, post-emergence damping-off but decreased survivals all at the medium or high concentration of this element in the nutrient solution while the decrease in these criteria were noticed at the maximum concentration of nitrogen used. It increased disease index in both varieties and decreased total sugars especially in the susceptible variety (Giza 74).

Total amino acids decreased as the nitrogen in the nutrient solution increased up to the medium level in the susceptible one and phenol compounds were also decreased.

Total pigments were increased as nitrogen increased in the solution of both varieties.

The absorption of Zn, Mn and Cu by the susceptible variety generally increased by increasing N in the nutrient solution.

3- Phosphorus (P):-

Application of low or high P-increased germination in both varieties but increased post-emergence damping-off in the resistant variety and increased survivals in general. Disease index was suppressed by low or high concentration of this element in the nutrient solution in the susceptible one.

Dry weight was increased in both varieties in both seasons by P application in high levels.

Total sugars were also increased with the increase of phosphorus in the nutrient solution in both varieties.

There were no effect either in total amino acids or phenolic compounds while total chlorophylls and carotenoids were flactuated in plants with P concentration in the solution especially in the susceptible variety.

Phosphorus uptake was increased by increasing its concentration in the nutrient solution.

4- Potassium (K):

High K decreased germination in the resistant while increased it and survivals in the susceptible variety. It increased dry weight in both varieties.

No regular effects either in phenols, sugars or amino acids in the resistant variety (Giza 69) were found while increasing potassium in the nutrient solution seemed to increase phenols in the susceptible variety.

High K enhanced the pigment concentration in leaves of susceptible variety.

Increasing K decreased phosphorus and Ca in both varieties and decreased Fe and Cu content in susceptible variety . However, this decrease was very small to affect general plant growth.

5- <u>Calcium (Ca):</u>

Germination was enhanced by application of this element at the moderate level in the resistant variety. Low or high Ca decreased the germination and survivals in the susceptible variety.

It decreased the disease index of the resistant one while it increased it in the susceptible one.

Calcium had its favourable effect on growth of plants especially in the susceptible one when used at the medium level.

It increased total sugars, phenols and total amino acids especially in Giza 69 variety and phenols in Giza 74 variety by its application at high levels.

Calcium at low levels increased the pigments of Giza 69 variety while it increased them in the susceptible variety will all its levels particularly the high one.

High Ca increased P absorption in both varieties while nitrogen content was decreased only in the susceptible one.

Calcium at low level increased Fe and Zn in the resistant variety while it decreased them in the susceptible variety. The reverse was true in Mn and Cu in the susceptible one.

6- <u>Zinc(Zn):</u>

It improved germination and survivals when used at low concentration in Giza 69 and suppressed them in Giza 74.

At low levels, it decreased the disease index especially with the susceptible variety as well as increasing the dry weight particularly in the susceptible one. Furthermore, Zn stimuated the formation of sugars, phenols, total amino acids in both varieties particularly in the resistant one. Moreover, it increased the total chlorophylls in both varicties especially the resistant one at all its levels in the nutrient solution.

Carotenoids were increased in the resistant one at low or high Zn application. While the reverse was true in the susceptible variety.

Zn at low level had improving effect on both P and Ca absorption by resistant one and the opposite on the susceptible one. High Zn decreased Fe absorption in the resistent one but low or high Zn increased it in the susceptible one.

Increasing Zn in the nutrient solution increased its uptake by the susceptible variety.

7- Boron (B) :-

It had its improving influence on germination and survivals in both varieties. Furthermore, it decreased the disease index and increased the dry weight more in the resistant one than the susceptible one on the condition that its concentration in the nutrient solution will be at the medium level.

Boron decreased the foliar contents of sugars, phenols, total amino acids and the pigments particularly in the resistant one while increased chlorphylls and carotenoids in the susceptible one.

Boron had its enhancing influence on the uptake of N,P and K while decreased the absorption of Ca in the resistant variety.

8- Copper (Cu):

It increased germination, survivals in both varieties especially the resistant one. It decreased the disease index in the susceptible one but it seemed to increase the dry weight in both varieties.

It increased the total amino acids while did not affect the phenols or sugars in the resistant cv. and decreased phenols and sugars in the susceptible cv.

The chlorophylls were increased in both varieties by Cu application.

Cu at the medium level had its influence in the nutrient concentration in the leaves as it increased P, Ca and K in both varieties especially in the first season.

Also, it increased Zn but decreased Fe in the susceptible one.

9- Manganese (Mn):-

It increased germination particularly in the resistant variety.

It increased the post-emergence damping-off when used at the highest concentration in both varieties while the lower concentration increased the survivals in both varieties.

Mn improving effect on growth (dry weight) was fairly in resistant but considerably in the susceptible variety.

At fairly high levels, Mn increased the total sugars and amino acids in the resistant while decreased them in the susceptible cv.. Furthermore, Mn increased carotenoids in the resistant variety while increased chlorophylls in the susceptible variety.

Mn increased the absorption of P while it decreased Ca in the resistant one and did not affect K, P or Ca in the susceptible one.

Mn at medium levels in the nutrient solution encouraged its absorption by both varieties of cotton plants under investigation.

From all results and discussion previously presented the following recommendations can be easily deduced:

1- The use of potassium in cotton nutrition might be advisable to induce the growth and suppress the disease.

2- Phosphorus application to these plants is also recommended especially when it is well known that the Egyptian soil is severely contaminated with this fungus.

3- Nitrogen at excessive use might render plants more susceptible to infection with this fungus.

4- Zinc as inducive of chlorophylls, growth,sugars, phenols and total amino acids and inhibitive of disease, its application at moderate levels is recommended for the plants under investigation.

5- Calcium as inducing P absorption, growth and chemical contents of the susceptible cotton plants could be applied at — moderate levels for the nutrition of cotton growing in infested soils.

6- It might be adventageous to use Mn at its regular concentration in the nutrition of cotton varieties for improving its growth and P absorption.

REFERENCES

Abou- Zaid, M.I. (1977)
Studies on some cotton diseases in the A.R.E . M.Sc. Thesis, Fac. of Agric. Zagazig Univ.

Alieva, V.I. (1962)
Izv.Akad. Nauk. Azerbaidzhan SSR. Ser Biol. Nauk. No. 4:43-51. (c.f. El-Hamawy H. 1980. Problems in plant nutrietion. Min.Agric., Egypt, Tech. Bull., 2.,1980).

Anthoni Raj, S. and K. Mahadevan (1970)
Introduction of wilt resistance in cotton by phenolic compounds. Indian Phytopath., 23:89-94.

Ashour, W.A.; A.R. Sirry; H.A. mohamed and I.E. Darrag(1964).
Studies on Fusarium wilt of cotton in the U.A .R. II-Effect of potassium and phosphatic fertilizers. Egypt Agric. Org., Bahtim Exp. Sta., Tech.Bull., 68,I.

Bacot, A.m. (1954)
The chemical composition of representative grades of the 1952 and 1954 crops of flue cured tobacco. U.S. Government printing office., Washington 1960.

Bell, A.A . (1969).
Formation of gossypol in infected or chemically irritated tissues of Gossypium species. Phytopathology, 57: 759-764.

Briton-Jones, H.R.(1922).
A wound parasite of cotton bolls. Techn and Sci. Service.Min.Agric.Egypt Bull., No.19.

Brown, J. D. and O. Lilliland (1946)
Rapid determination of Potassium and Sodium in plant material and soil extracts by flame photometer. Proc. Am. Soc. Hort. Sci., 48:341-346.

Chi., C.C. and E.W. Hanson (1962).
Nutrition in relation to root and top growth of *Trifolium protenase* and severity of *Fusarium* root-rot. Phytopathology, 52:728.

Corden, M.E. (1965).
Influence of Calcium nutrition on *Fusarium* wilt of tomato and polygalacturanase activity. Phytopathology, 55:222-224.

------------ and L.V. Edington (1960)
A calcium requirement for growth regulator induced resistance to *Fusarium* wilt of tomato. phytopathology, 50:625-626.

Edington, L.V. and J.C. Walker (1958).
Influence of calcium and boron nutrition on development of *Fusarium* wilt of tomato. Phytopathology, 48:324-326.

El-Nur, E., and M.A .A. Fattah (1970)
Fusarium wilt of cotton. Tech. Bull (2) N.S. Sudan: Gezira Research Station. (c.f. Ebels, D.L., 1975, Cott. Grow. Rev.52:295-339).

Fahim, M.M.; B.A.Youssef and T.El-Sharkawi (1971).
Effect of fertilization and microelements on cotton wilt incidence, U.A. R. Microbiol., 6 No. 1-2, 11-21 (1971).

Fakhrudinova, F.K. (1975).
Zinc uptake by cotton in relation to rates of phosphorus fertilizers, (c.f. Field crop Abst., 1976 vol. 29 No.8)

Fisher, P.L. (1935).
Physiological studies on the pathogenicity of Fusarium lycoparsici Sacc. for the tomato plant. Maryland Univ. Agr. Exp. Sta. Bull., 374: 261-281.

Foster, R.E., and J.C. Walker (1947).
Predisposition of tomato to Fusarium wilt. J. Agric. Research 74:165-185.

Gaumann, E. (1957).
Fusaric acid as a wilt toxin. Phytopathology, 47:342-357.

Gubanov, G.Y.A. and B.G. Sabirov (1972).
Transmission of Fusarium wilt infection by cotton seed. Khlopkovodstvo 22(3): 22-23. (c.f. Rev. Plant Pathology, 51(1): 3376.

Haag, H.P., E. Balmer and M. Kuromoto (1971).
Absorption and distribution of P, in cotton varieties resistant and susceptible to cotton wilt. Rev. Plant Pathology, 52(2): 2620,1973.

Harfoush (Dorrya). I (1975).
Studies on Fusarium oxysporum attacking the roorts of bean plants. Ph. D. Thesis Fac. of Agric., Ain-Shams Univ., Cairo.

Jackson, M. L., (1967).
Soil chemical analysis. Prentice. Hall Pvt. ltd. India. pp.398.

John,M.K. (1968)
Colorimetric determination of phosphorus in soil and plant materials with ascrobic acid. (c.f. Soil Sc.Am.Proc., 109(4) :214-220, 1970).

Kati Reddy, M. and A. Mahadevan (1967).
Effect of phenolic compounds on cellulase Indian phytopath., 20:265-267.

Karaev, K.C.C. (1965).
The role of organic fertilizers in controlling *Fusarium* wilt. Rev. Appl. Mycol., 45:148,1966).

Krishnamani, M.R.S., and M., Lackshmanan (1976).
Photosynthetic changes in *Fusarium* infected cotton.
Can.J.Bat., 54:1257-1263.

Kuzentsov, V.P. (1964).
Importance of microelements in the control of wilt and increase of cotton yield. Rev. Appl. Mycol., P 148 (1966).

Lakshminarayanan, K, (1955).
Role of cystine chelation in the mechanism of *Fusarium* wilt of cotton. Experientia, 11:388. (c.f. Youssef, Y.A. and Khairia, A. Youssef 1971).

Mahadevan, A. (1966).
In into production of indol acetic by *Fusarium oxysporum vasinfectum* Atk. Experientia, 22:433.

Mathre, D.E. (1968).
Photosynthetic activities of cotton plants with *Verticillium albo-atrum* Phytopathology, 58:137.

Mc New George, L. (1953).
The effect of soil fertility U.S.D.A., year book, "Plant Diseases" p.100

Miles, L.E.(1936)
Effect of potash fertilizers on cotton with. Missinssippi Agric. Exper. Sta. Tech. Bull. 23,21 p. (c.f. Walker, J.C., and W.J.Hooker. 1945).

Mohamed, H.A., and I.E.Darrag, (1964).
Fusarium wilt of cotton in the United Arab Republic. IV-Effect of nitrogenous fertilizers. Plant Dis. Reptr.,48:950-953.

Naim, M.S., and A.S. Shabaa (1965).
Relation of nitrogen fertilizers to growth vigour of *Fusarium* wilted cotton. Phytopath. Mediterranea, 4(3):145-153. (c.f. Rev. Plant pathology, 1967.46(1) 26)

-----------,H.H. Sharaubeem and A.H Antionette(1966).
The relation of different nitrogen levels to the incidence of vascular wilt and growth vigour of Egyptian cotton. (c.f. Rev. Appl. Mycol., 1966.45(2)3148).

Neal, D.C. (1927).
Cotton wilt. Apathological and physiological investigation. Ann. Mo. Bot. Gardens,14,329.

Nerozi, S.A. and m.A. and M.A. Belousev (1972)
Effect of different levels of nutrition on the re-utilization of nutrient in cotton leaves; Tashkent uzbek SSR (1972) 68-74. (c.f. Field crop Abst., 1972.25(1)-891).

Poletzhaya, L.N., N.T. Kiseleva, V .P. Crina. and E .I.saryeva (1973).
Effects of nitrogenous fertilizers on <u>Fusarium</u> <u>oxysporum</u> f. <u>vasinfectum</u> and its toxicity. (c.f. Rev. Plant pathology,1974.53(2).

Pearse, H.L.(1944)
Farming S. Africa. 19:688-694. (c.f. Proplems in plant nutrition, El-Hamawy H.Min.Agric., Egypt, Tech. Bull., 2.1980.

Perry, D .A . (1962)
Methods for determining the reaction of cotton plant to <u>Fusarium</u> wilt. Emp. Cott.Grow.Rev., 39:22-26.

Piper, C.S. (1947)
Soil and plant analysis: 258-275. Interscience Publishers, Inc. New York.

Ranker, E.R. (1927)
Determination of total nitrogen. J. Assoc. of Agr. Chemist. (c.f. Scott. L.E. (1951). Chemical analysis. Hort. Lab., Method sheet 13 U of Md.USA.

R'Ohringer, R.D. Samborski, and C .O. Person (1961).
Effect of <u>Fusarium</u> <u>oxysporum</u> f.sp. <u>lycopersici</u> and its metabolites on tomato.Agric. and Food chem., 6:838-843.

RonCadori, R.W., S.M.Mc Carter, J.L. Crowford (1971)
Influence of fungi on cotton seed deterioration prior to harvest. Phtcpathology, (1971) 61(11): 1326-1328.

Rosen, H. 1957
Amodified Ninhydrin colorimetric analysis for acid nitrogen. Arch. Biochem. Biophys., 67:10-15.

Rost, L.E. (1922).
Control of cotton wilt by the use of potash fertilizer. J.Am.Soc. Agron., 14.222.

Sadasivan, T.S. (1958).
Moulds metabolites, and tissues, Proc. Indian Sci. Congr., 45 th. Congr.,1 (1958)

---------------- and C.V. Subramonian (1954).
"Plant Pathology" edited by Horsfall, J.G. and Dimond, A.E., New York and London, Vol. 11,p.715 (1960).

Sharoubeem H.H., M.S. Naim and A.A. Habib (1966a).
Effect of different levels of potassium on growth vigour of cotton variety plants in relation to Fusarium spp. associated with the vascular wilt disease. Mycopath. Myco. (App. 29(1-2): 65-81). (c.f. Rev. Appl. Mycol., 1966. 45(2). 3147).

Sharoubeem, H.H., M.S. Naim and A.H. Antoinette (1966b). Interaction of phosphorus and *Fusarium* wilt the major element nutrition of cotton plants. Acta Phytopath. A cad. Sci., hung., 1(1-21 53-65. A'in Shams Univ. Cairo, UAR. (crf. Rev. Plant Pathology, 1967, 46 (1): 625).

———————. M.S. Naim and A.H. Antoinette (1967). Potassium, nitrogen and phosphorus in relation to the incidence of cotton wilt caused by *F. oxysporum vasinfectum*. Microbiol. U.A.R.,2,1.

Shaw, M. (1963). The physiology and host-parasite relations of the rusts. Ann. Rev. Phytopath., 1:259-294.

Singh, S.P. (1961). Indian J. Agr. Sci. 31: 11-15.

Smith, A.L. (1940). Aregional study of the relationship of potash treatments to the development of cotton wilt under widely varying condition of soil and Enviroment. Phytopathology,30,707.

Smith, A.L. (1953). *Fusarium* and nematodes on cotton. U.S.D.A. Yearbook,"Plant Disease" pp.292.

Snell, F.D., and C.T. Snell (1953).
Colorimetric methods of analysis including some turbidimetric and nephelometric methods. Vol III Organic 606 pp. D. Van Nostrand Company, Inc. Toronto-New York-London.

Stepantsev, I.N., (1957).
Disease causing cotton wilt and their control. App. Mycol., Rev., 37:662-663.

Stoddard, D.L. (1942).
Fusarium wilt of cantaloupe and studies on the relation of potassium and nitrogen supply to susceptibility. Trans. Penin. Hort. Soc. 31: 91-93. (c.f. Halker, J.C. and W.J. Hooker. 1945).

Subbitma, N.V. (1961).
Effect of wilting on transformation of corbohydrate. Fizid., Rastenu, Akad. Nauk. S.S.R., 8:283-297.

Sulochana, C.B., (1952a)
Soil condiditions and root diseases VII. Response of cotton plants to micro-elements and its relation to the disease development. Ind. Proc. Acad. Sci. Sect. B., 36:234-242 (c.f. Ebels, D.L., 1975, Emp. Cott;, Grow Rev. 52: 295-339).

Sulochana, C.B., (1952b).
Proc. Indian Acad. Sci., 36b: 234-242.
(c.f. El-Hamawy, H. 1980. Problems in Plant nutrition. Min. Agric. Egypt, Tech. Bull 2, 1980).

Tagi-Zade, A.Kh. (1954).
Trudy Azerbaidzhhan Univ., 6:45-56. (c.f. El-Hamawy, H. 1980. Proplems in plant nutrition. Min. Agric. Egypt, Tech. Bull.2,1980).

Thomas, W., and R.A. Dutcher (1924)
The oolorimetric determination of carbohydrates is plants by the picric acid reduction method. 1. The estimation of reducing sugars and sucrase. Jour. Amer. Chem. Soc., 46:1662-1669.

Ticdale, H.B. and J.B. Dick (1942).
Cotton wilt in Alabama as affected by patash supplements and as related to varietal behaviour and other agronomic problems. J. Am. Soc. Agron., 34,405.

Walker, J.C. and W.J. Hooker (1945).
Plant nutrition in relation to disease development II Cabbage yellows. A.J. Botany 32: 314-320.

Wallace, A. (1963).
Solute uptake by intact plants. Edited by Arthur Wallace, Prof. of plant nutrition UCLA, LA 90024 Calif.

Youssef, Y.A. and Khairia A.Youssef (1971a). Studies on *Fusarium* wilt of cotton. V- Differences in contents of free amino acid and sugars of seedlings of susceptible and resistant cotton varieties raised in *Fusarium* inoculated or uninaculated soil. U.A.R. Phytopath., 3:33-48.

Young, V.H. (1947). Relation of enviromental to incidence of *Fusarium* of cotton. Abst., Phytopathology, 37:437.

________ and W.H. Tharp (1941). Relation of fertilizer balance to potash hunger and the *Fusarium* wilt of cotton. Arka-nsas Agric. Exper. Sta. Bull. 440,24p. (c.f. Walker, J.C and W.J. Hooker, 1945).

Zhukova, M.I. (1972). Effect of K deficiency on physiological and biochemical changes in cotton plants. Tashkent uzbek SSR (1972)40-59 (c.f. Field crop Abst., 1972. 25(1) 898).

Zununov, C.H.Z. and I.M. Lipkind (1969). Effect of fertilizers on contents of N, P,K and pigments in cotton leaves. (c.f. Field crop Abst., 1971 (1) 1033).

"بسم الله الرحمن الرحيم"

دراسات فسيولوجية على نباتات القطن المحقونة بفطر فيوزاريوم أوكسيسبورم فازينفيكتم

رسالة مقدمة من

عبده مهدى محمد مهدى

بكالوريوس فى العلوم الزراعية

كلية الزراعة - جامعة الزقازيق - ١٩٧٦

كجزء من المتطلبات للحصول على درجة الماجستير

فى

العلوم الزراعية (فسيولوجى نبات)

قسم امراض النبات والوراثة

كلية العلوم الزراعية بمشتهر

جامعة الزقازيق

"فرع بنها"

١٩٨١

دراسات فسيولوجيـــة

على نباتات القطن المحقونة بفطر فيوزاريوم اوكسيسبورم فازينفيكتـــم

يعتبر القطن أحد محاصيل الحقل الهامة فى مصر كما يعتبر أهم محصول تصديـــرى حيث يصدر للخارج لجلب المزيد من العملات الصعبة بالاضافة الى أن جزءا كبيرا منـــه يصنع محليا • ولقد قدرت وزارة الزراعة المساحة المنزرعة منه فى عام ١٩٧٩ (١١٩٥٥٢٩ فدان) حيث اعطت محصول قدر بـ ٩٦٧١٨٩٧ قنطار مترى • ويصاب القطـــن بعديد من الامراض الحشرية والفطرية والفسيولوجية • ويعتبر مرض الذبول الفيوزاريومـــى أحد الأمراض الفطرية الهامة التى تصيب بادرات القطن خاصة فى المناطق الشمالية مما يسبب خسائر كبيرة لهذا المحصول الهام وكان لهذا المرض دور كبير فى اختفاء كثير من الاصنـــاف الهامة بداية بالاشمونى وانتهاء بصنفى كرنك وجيـــزة ٧٤ •

ومنذ أمد بعيد يحاول الباحثون ايجاد الوسائل التى يمكن بها تقليل أو مقاومـــة الاصابة بهذا المرض •

وفى محاولة لمعرفة تأثير العناصر المغذية المختلفة ذات المستويات المتدرجـــة فـى المحلول المغذى على احتمال مقاومة مرض الذبول الفيوزاريومى الناشــئ عن الاصابـــة الصناعية بجراثيم فطر الفيوزاريوم اوكسيسبورم فازينفيكتم اصنفيـــن من القطن جيـــزة ٦٩ المعروف بالمقاومة وجيزة ٧٤ المعروف بقابليته للاصابة زرعت بذور هذين الصنفيـــن بعد تلويثها بجراثيم هذا الفطر فى اصص تحتوى على الرمل النقى المغسول والملوث ايضـا بنفس الجراثيم ثم بدأت المعاملات بعد الزراعة بباقيها المعاملة الغير ملوثة للمقارنة والمعاملـة الملوثة التى تسـتغذى بكل العناصـــر بالتركيزات المناسبـــة •

واثناء النمو والملاحظة المستمره لحالة النباتات أخذت القياسات لكل من نسبة الانبـات

ونسبة البادرات الميته بعد الانبات ثم نسبة النباتات المتبقية ومعامل حدوث الاصابـــة ونمو البادرات متمثلا فى الأوزان الخضرية والجافة لكلا من المجموع الجذرى والمجمـــوع الخضرى للنبات كما قدرت المكونات العضوية النباتية مثل السكريات والفينولات والاحماض الأمينيـة الكليـة والصبغات النباتيـة (الكلوروفيـلات والكاروتينودات) كما قدرت ايضـا محتويات الأوراق من العناصر المغذيـه .

وتتلخص أهم النتائج المتحصل عليها من كلا الموسميـن فيما يلـى : —

(١) التلوث بجراثيم هذا الفطر ادى الى نقص نسبة الانبات خصوصا فى الصنف القابـل للاصابه جيزة ٧٤ كما زاد من نسبة البادرات الميته بعد الانبات بينما أدى الـى نقص نسبة النباتات المتبقية بعد الانبات كما أن معامل حدوث الاصابة ارتفـــع بينما انخفض النمو خصوصا فى الصنف القابل للاصابة جيزة ٧٤ كما انخفـــض ايضا مستوى الاحماض الامينية الكلية كما زادت من مستوى الفينولات فى الصنــف الحساس بينما أدى الى أنخفاض الصبغات النباتية خاصة فى الصنف الحســاس جيزة ٧٤ أكثر من الصنف المقاوم جيزة ٦٩ . كما أن الاصابة الصناعية عطلــت من امتصاص كل من الفوسفور والبوتاسيوم وكان هذا التعطيل فى الصنف الحســاس أكثر من الصنف المقاوم كما عطلت ايضا من امتصاص الزنك والنحاس فى الصنف الحساس .

(٢) النيتروجيـــن :

ادت زيادة النيتروجين الى تحسين نسبة الانبات ولكنه ادى الى زيادة نسبـــه البادرات الميته بعد الانبات وتقليل نسبة النباتات الباقية بعد الانبات عندمـــا أستعمل بتركيـز عالى . كما أدى الى زيادة معامل الاصابة فى الصنفين وقلل مـــن

محتوى السكريات خاصة فى الصنف الحساس كما انخفضت نسبة الاحماض الامينيه بزيادة تركيز النيتروجين فى المحلول المغذى وايضا نقصت المركبات الفينوليه فـــى الصنف الحساس بينما زادت الصبغات النباتيه بزيادة تركيز النيتروجين فى الصنفـين اما عن امتصاص العناصر الغذائية فقد زادت بزيادة النيتروجين فى المحلول المغذى خاصة فى الصنف الحساس جيزه ٧٤ ٠

(٣) الفوسفــور :

كان لاضافة الفوسفور فى التركيزات العالية او المنخفضه تأثير مشجع للانبات فى الصنفين كما ادى الى زيادة نسبة عدد النباتات المتبقية بعد الانبات بصفة عامه٠

وكان لاستعمال الفوسفور بتركيز منخفض او عالى فى المحلول المغذى تأثـــير مثبط على معامل الاصابه خاصة فى الصنف الحساس جيزه ٧٤ ٠ وقد لوحظ جليـــا زيادة الوزن الجاف لكلا الصنفين فى الموسمين ٠ كما أن المحتوى السكرى زاد بزيادة الفوسفور فى الصنفين ولم يكن هناك تأثير واضح على الاحماض الامينية أو المركبـــات الفينوليه بينما الكلوروفيلات والكاروتنويدات كانت متأرجحه فى النباتات بزيادة الفوسفور خاصة فى الصنف الحساس جيزه ٧٤ ٠ كما أن زيادة الفوسفور فى المحلول المغـــذى ادت الى زيادة امتصاصه للنباتات ٠

(٤) البوتاسيـــوم :

ادى البوتاسيوم فى التركيز العالى الى نقص نسبة الانبات فى الصنف المقاوم جيزه ٦٩ بينما ادى الى زيادة نسبة الانبات ونسبة النباتات المتبقية بعد الانبات فى الصنف الحساس جيزه ٧٤ وايضا ادى الى زيادة الوزن الجاف فى الصنفـــين

ولم يكن هناك تأثير واضح فى زيادة البوتاسيوم فى المحلول المغذى على المركبات الفينوليه او السكريات او الاحماض الامينيه فى الصنف المقاوم جيزه ٦٩ بينما ادى الى زيادة الفينولات وتحسين تكوين الصبغات النباتية فى الصنف الحساس جيزه ٧٤ • وأدى ايضا الى خفض امتصاص الفوسفور والكالسيوم فى الصنفين والحديد والنحاس فى الصنف الحساس جيزه ٧٤ • وعلى الرغم من ذلك فان هذا النقص لم يكن بالدرجة التى توثر على النمو العام للنبات •

(٥) الكالسيوم :

كان لاستعمال الكالسيوم بتركيز متوسط اثرا فى زيادة نسبة الانبات فى الصنف المقاوم جيزه ٦٩ بينما التركيز العالى أو المنخفض ادى الى نقص نسبة الانبات وكذلك نسبة النباتات المتبقية فى الصنف الحساس جيزه ٧٤ • كما أدى زيادة الكالسيوم فى المحلول المغذى الى خفض معامل الاصابه فى الصنف المقاوم بينما ادى الى زيادته فى الصنف الحساس جيزه ٧٤ •

وكان لاستعمال الكالسيوم بتركيز متوسط تأثير مشجع على نمو النباتات خصوصا فى الصنف الحساس جيزه ٧٤ • وكان لاستعمال الكالسيوم بتركيز عالى فى المحلول المغذى اثرا فى زيادة كل من السكريات الكليه والفينولات والاحماض الامينية خصوصا فى الصنف المقاوم جيزه ٦٩ • اما استعماله بتركيز منخفض فكان له اثرا فى تحسين الصبغات النباتية فى الصنف المقاوم جيزه ٦٩ بينما جميع تركيزاته أدت الى تحسينها فى الصنف الحساس جيزه ٧٤ • كما ادى الكالسيوم العالى الى زيادة امتصاص الفوسفور فى كلا الصنفين بينما أنقص امتصاص النيتروجين فى الصنف الحساس جيزه ٧٤

أما فى تركيزه المنخفض فانه زاد من امتصاص الحديد والزنك فى الصنف المقاوم بينما انقص امتصاص الحديد والزنك وزاد كلا من المنجنيز والنحاس فى الصنف الحساس جيزه ٧٤ ٠

(٦) الزنـــــك :

حسن الزنك كلا من نسبة الانبات ونسبة النباتات المتبقية فى الصنف المقاوم جيزه ٦٩ ٠ عندما استعمل بتركيز منخفض بينما ادى الى خفض هذه النسب فى الصنف الحساس جيزه ٧٤ ٠ وايضا انقص معامل الاصابه وزاد من الوزن الجاف كما أنه حسن من انتاج السكريات والفينولات فى الصنفين وعلى الاخص فى الصنف المقاوم جيزه ٦٩ ، أضف الى ذلك ان جميع مستوياته زادت من الكلوروفيـــلات الكلية خاصة فى الصنف المقاوم جيزه ٦٩ ٠ بينما التركيز العالى أو المنخفــض أدى الى زيادة الكاروتنويدات فى الصنف المقاوم جيزه ٦٩ ٠ وكان العكس فـــى الصنف الحساس جيزه ٧٤ ٠ كما كان لاستعمال الزنك بتركيز منخفض اثر محســن على امتصاص الكالسيوم فى الصنف المقاوم جيزه ٦٩ ٠ وكان العكس فى الصنـــف الحساس جيزه ٧٤ ٠ اما استعمال الزنك بتركيز عالى فقد ادى الى خفض امتصاص الحديد فى الصنف المقاوم جيزه ٦٩ ٠ اما فى الصنف الحساس جيزه ٧٤ فان التركيز المنخفض او العالى زاد من أمتصاص الحديد وادت زيادة الزنك فـــى المحلول المغذى الى زيادة امتصاصة فى الصنف الحساس جيزه ٧٤ ٠

(٧) البـــورون :

حسن الانبات والنباتات المتبقية فى الصنفين وانقص معامل الاصابة وزاد من الوزن الجاف زيادة كبيره فى الصنف المقاوم جيزه ٦٩ ٠ عن الصنف الحساس

جيزه ٧٤ بشرط الا يتعدى تركيزه فى المحلول المغذى التركيز المعتاد ٠ كما أدت جميع تركيزاته الى خفض السكريات والفينولات والاحماض الامينية والصبغات النهائية خاصة فى الصنف المقاوم جيزه ٦٩ بينما أدت زيادته فى المحلول المغذى الى زيادة الكلوروفيللات والكاروتنويدات فى الصنف الحساس جيزه ٧٤ ٠ وكان له تأثير مشجع على أمتصاص النيتروجين والفوسفور والبوتاسيوم وادى الى تثبيط امتصاص الحديد فى الصنف المقاوم ٠

(٨) النحاس :

ادت زيادة النحاس فى المحلول المغذى الى زيادة الانبات والنباتات المتبقية بعد الانبات فى الصنفين خصوصا الصنف المقاوم جيزه ٦٩ ٠ كما انقص معامل الاصابة فى الصنف الحساس جيزه ٧٤ ويبدو أنه يزيد من الوزن الجاف فى الصنفين وخاصة فى المستويات المتوسطة وزاد ايضا من الاحماض الامينية الكلية ولم يؤثر على الفينولات والسكريات فى الصنف المقاوم جيزه ٦٩ ٠ بينما ادى الى خفضهم فى الصنف الحساس جيزة ٧٤ ٠ كما ادى زيادة النحاس فى المحلول المغذى فى الصنف الحساس الى زيادة الكلوروفيلات وكان للنحاس فى تركيزاته المتوسطه اثرا على المحتوى المنصرى فى الاوراق فقد زاد من امتصاص الفوسفور والكالسيوم والبوتاسيوم فى الصنفين خصوصا فى الموسم الاول وايضا زاد من امتصاص الزنك ولكنه انقص امتصاص الحديد فى الصنف الحساس جيزه ٧٤ ٠

(٩) المنجنيز :

زاد المنجنيز من نسبة الانبات فى الصنف المقاوم جيزه ٦٩ وايضا زاد من نسبة النباتات الميته بعد الانبات عند استعمالة بالتركيزات العاليه فى الصنفين

بينما التركيز المنخفض زاد من نسبة النباتات المتبقية فى الصنفين • وكان له تأثيرا على الوزن الجاف اكثر فى الصنف الحساس جيزه ٧٤ عنه فى المقاوم جيزه ٦٩ •

وكان لاستعمال المنجنيز بتركيز عالى نوعا ما اثرا فى زيادة السكريات الكليه والاحماض الامينية فى الصنف المقاوم بينما ادى الى نقصهم فى الصنف الحساس جيزه ٧٤ • أضف الى ذلك ان المنجنيز زاد الكاروتنويدات فى الصنف المقاوم بينما انقص الكلوروفيلات فى الصنف الحساس جيزه ٧٤ • كما زاد المنجنيز من امتصاص الفوسفور وانقص امتصاص الكالسيوم فى الصنف المقاوم جيزه ٦٩ ولم يوثر على امتصاص البوتاسيوم والفوسفور والكالسيوم فى الصنف الحساس جيزه ٧٤ •

وكان لتركيزاته المتوسطه اثرا مشجعا فى زيادة امتصاصه من المحلول المغذى فى كلا الصنفين •

من النتائج والمناقشات السابقه يمكن استخلاص التوصيات التاليه :-

١) استعمال البوتاسيوم فى تغذيه نباتات القطن يمكن أن ينصح به لتشجيع النمو وتثبيط المرض •

٢) استعمال الفوسفور لهذه النباتات ايضا يوصى به خصوصا اذا كان من المعروف ان الاراضى المصرية ملوثه بشده بهذا الفطر •

٣) استعمال النيتروجين بتركيز زائد عن اللازم قد يجعل النبات رخوا ومعرضا للاصابه بالفطر •

٤) عنصر الزنك كمشجع للكلوروفيلات وللنمو والسكريات والفينولات والاحماض الامينية و مثبط للمرض ينصح باستعماله عند تركيزات متوسطه •

٥) الكالسيوم كمشجع لامتصاص الفوسفور والنمو وتكوين المحتويات الكيميائية فـــى النباتات الحساسة يمكن ان يستعمل عند تركيزات متوسطه لتغذية نباتـــات القطن النامية فى ارض ملوثه بهذا الفطر .

٦) قد يكون استعمال المنجنيز بتركيزات أعلى قليلا من التركيز العادى مفيـــدا لتغذية نباتات القطن وتشجيع نموها وأمتصاص الفوسفور .